STATE OF NEW YORK

DEPARTMENT OF CONSERVATION

WATER POWER AND CONTROL COMMISSION

THE GROUND-WATER RESOURCES OF MONTGOMERY COUNTY, NEW YORK

By

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Prepared by the

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CONTENTS

CONTENTS—(Continued)

ILLUSTRATIONS

TABLES

THE GROUND-WATER RESOURCES OF MONTGOMERY COUNTY, NEW YORK

By RUSSELL M. JEFFORDS

ABSTRACT

This report is part of a State-wide survey by the U. S. Geological Survey in cooperation with the New York Water Power and Control Commission. It describes the ground-water resources of Montgomery County, in the Mohawk Valley region of New York. The County has an area of about 400 square miles, and in 1940 included a population of 59,142. Dairy farming and manufacturing comprise the principal occupations.

The exposed rocks range in age from pre-Cambrian to Recent; they include the crystalline schists and gneisses of the Grenville series, the Cambrian Potsdam sandstone and Little Falls dolomite, and the Ordovician Tribes Hill, Lowville, Amsterdam, and Glens Falls limestones, Canajoharie and Utica shales, and Schenectady formation, and possibly the Frankfort shale. Surficial deposits of glacial till, clay, sand, and gravel, together with Recent alluvium, cover the older rocks and form the surface of much of the county. Included is a map showing the areas where the several rock formations crop out at the surface or beneath the surficial deposits, and the character and water-bearing properties of each formation are described. Results of a preliminary study of the insoluble residues of the several formations are included as an aid to identification of the formations on the basis of well cuttings.

The ground-water reservoirs are recharged principally by precipitation within the area, although some water moves through the water-bearing formations from adjacent areas and into permeable unconsolidated material from adjacent streams. Essentially all rural stock and domestic water supplies and an important proportion of the urban and rural industrial and commercial supplies are obtained from ground-water sources. Most wells in the county are drilled, but dug wells are numerous in rural sections and driven wells and springs are used locally. The ground water is suitable generally for most ordinary uses, but commonly it is hard and may contain objectionable concentrations of iron and hydrogen sulfide gas. Very deep wells may encounter highly mineralized water that is not potable.

The chief water-bearing formations comprise the Little Falls dolomite, the Canajoharie and Utica shales, and unconsolidated deposits of till and gravel. The present use of ground water does not exceed the annual recharge, but heavily pumped areas in Canajoharie and Amsterdam may be approaching a critical condition. Additional ground-water supplies for stock and domestic use may be obtained throughout essentially all the county by means of drilled wells. Somewhat larger supplies—perhaps very large supplies at a few places—may be developed locally from gravel deposits at favorable places along the Mohawk River.

Basic data on which this report is based are given in tables. They include records of 365 wells and springs, chemical analyses of water from 28 wells, 1 spring, and 6 surface supplies, and logs of 8 water wells.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

A cooperative program of ground-water investigations in upstate New York was begun in 1945 by the New York Water Power and Control Commission and the Geological Survey, United States Department of the Interior. The purpose of the study is to collect and analyze data on the occurrence, quantity, quality, and development of ground water, to prepare for publication such information as would be of value to the citizens of the State, and to assist individuals and State, Federal, and municipal groups in the solution of problems relating to water supply from wells and springs. The areas in which ground-water studies have been completed and in which work is now in progress are shown in figure 1. Reports for Columbia, Delaware, Fulton, Greene, Saratoga, Schenectady, Seneca, Washington, and Wayne Counties are being prepared. Reports have been published for Albany, Rensselaer, and Schoharie Counties and for parts of Broome and Cortland Counties.

Ground water is one of the important natural resources in New York (Adams, 1937, pp. 69-72)[1] and hence there is a definite need for an adequate understanding of the occurence, quantity, and quality of the supply. Three of the eight municipalities served by public water-supply systems in Montgomery County rely directly upon ground water, and essentially all the rural domestic and stock supplies are obtained from wells or springs. In addition, an increasing number of industries and commercial establishments in both urban and rural areas are utilizing wells as a source of water. Ground water is inherently valuable as a natural resource, inasmuch as relatively large supplies are stored in the subterranean rock reservoirs for use at any time. Moreover, if withdrawals of ground water do not exceed safe limits, the supply is replenished periodically by local precipitation, seepage from streams, or both.

LOCATION AND EXTENT OF THE AREA

Montgomery County lies in east-central New York State along the Mohawk Valley (fig. 1). It is bordered on the west by Herkimer County, on the north by Fulton County, on the east by Saratoga and Schenectady Counties, and on the south by Schenectady, Schoharie, and Otsego Counties. The County is approximately rectangular in outline and extends about 35 miles east and west and 15 miles north and south. It comprises 10 political townships and includes an area of about 400 square miles.

PREVIOUS GEOLOGIC AND HYDROLOGIC WORK

Numerous studies have been made in the past relative to the geology of Montgomery County, but few investigations deal specifically with the ground-water resources. After preliminary geologic investigations of the Mohawk Valley by Eaton (1824), Montgomery County and adjacent parts of the Mohawk Valley were described in the preliminary and final reports on the geology of the third district of the Geological Survey of New York (Conrad, 1837; Vanuxem, 1838, 1839, 1840, 1841, 1842). Minor modifications were made in the conclusions regarding stratigraphic nomenclature by Hall (1847) and in glacial details by Dana (1863). Renewed investigation accompanied the construction of the old Erie Canal, and this gradually refined concepts regarding structural relationships (Darton, 1894), stratigraphy (Prosser and Cumings, 1897; Cumings, 1900; Cleland, 1900, 1903; Prosser, 1900; Cushing, 1905, 1911; Ulrich and Cushing, 1910; and Ruedemann, 1912), and glacial geology (Brigham, 1898; Fairchild, 1912).

Current information on the structural geology of Montgomery County and adjacent parts of the Mohawk Valley is summarized by Quinn (1933) and Megathlin (1938), glacial geology and unconsolidated sediments by Brigham (1929), and consolidated rock formations by Ruedemann (1925), Ruedemann and Chadwick (1935), and Kay (1937). General geologic data on New York State are contained in papers by Miller (1924) and Goldring (1931).

Few of these reports treat directly with ground-water conditions in the vicinity of Montgomery County, but some information is contained in reports by Fuller (1904, 1905).

[1] References are listed alphabetically at the end of this report.

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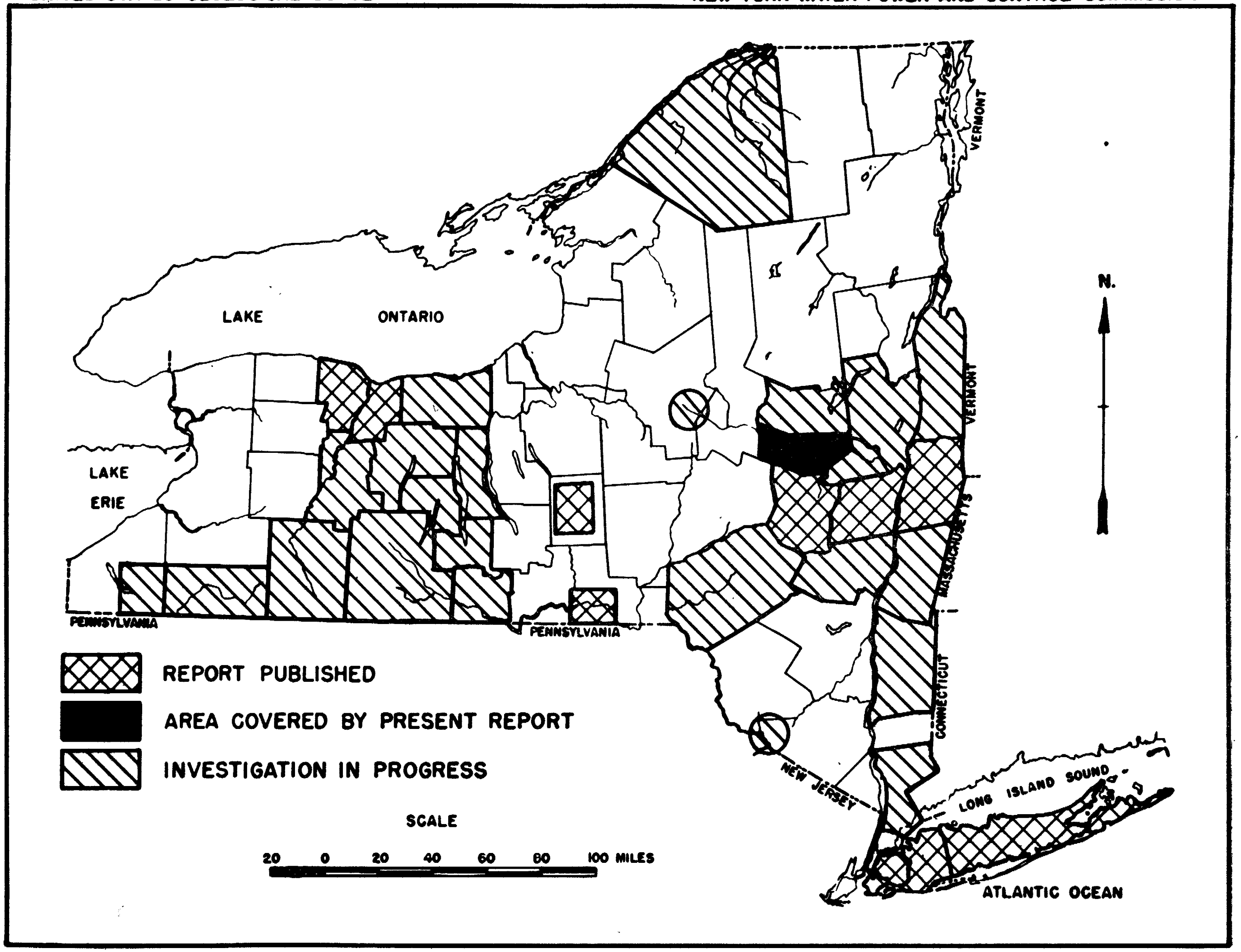

Figure 1.—Index map of New York showing areas of cooperative ground water studies.

An investigation of ground-water conditions in the vicinity of Canajoharie was made by M. L. Brashears, Jr., during the recent war, but this information was not published.

METHODS OF INVESTIGATION

A single observation well was established in Montgomery County in 1942 for use in the integrated network of observation wells in New York State. During the spring and summer of 1946, H. R. Rockefeller visited nearly 400 wells and springs in the county and obtained data on the depth, water-bearing material, yield, drawdown, water level, general character of the water, use, and other features. Much of this information was obtained from well owners, tenants, and well drillers. In many cases, only incomplete records for wells were available from well drillers and owners. Although a few well-drilling firms keep excellent records, a considerable number of drillers do not keep written records except for the depth of wells and lengths of casing used, so that in these cases other details of construction are reported from memory, if at all. In general, little attention is paid to unconsolidated materials overlying the bedrock. The necessity for detailed information about subsurface conditions for the economical development of ground-water resources, as well as for building foundations, etc., makes it imperative that well drillers maintain complete and accurate records, and by so doing they will render a valuable service to the people of the State, as well as benefit their own profession.

Samples of water collected from 27 representative sources, including 7 public supplies, were analyzed at the laboratory of the New York Department of Health in Albany. The Department of Health also furnished additional data on water analyses that had been made in earlier years.

Field work was carried on by the writer during the summer of 1946 to determine the areal distribution of the several water-bearing formations and other features relating to water supply. The areal geology of the consolidated formations shown in plate 2 was compiled from several earlier maps (Cumings, 1900; Merrill, 1901; Megathlin, 1938) and modified by the writer from field observations.

The locations of all wells and springs for which records are given are shown on plate 1. The wells have been numbered in order beginning with number Mt 1, and springs have been numbered in a separate series beginning with number Mt 1Sp. To aid the reader in finding a well or spring location on plate 1, it has been divided into rectangles which, at the margins, are lettered alphabetically from west to east and numbered from north to south. These coordinates are given in the tables of well and spring records. The other numbers and letters indicate respectively the distance in miles and direction from a corner of the rectangle in which a well or spring is situated. For example, well Mt 65 (9V, 2.4S, 1.4E) will be found 2.4 miles south and 1.4 miles east of the intersection of lines 9 and V. The prefix "Mt" in all well and spring numbers has been omitted on plate 1 but all wells and springs shown are in Montgomery County.

ACKNOWLEDGEMENTS

The writer is indebted to many residents of Montgomery County for their cooperation in furnishing information concerning water supplies. In addition, several well drillers and consulting engineers furnished valuable data regarding many of the deeper wells. Many State agencies contributed services. Among these are the State Department of Health, which cooperated by analyzing samples of water and by furnishing other analyses. Information on borings along the Mohawk River was obtained from the New York Department of Public Works at Utica. Acknowledgment is made also to John C. Thompson, Executive Engineer of the New York Water Power and Control Commission, to John Broughton, State Geologist, New York State Museum, and to colleagues in the Geological Survey, particularly E. S. Asselstine, for assistance and counsel during the preparation of this report. The work was done under the supervision of M. L. Brashears, Jr., District Geologist in charge of ground-water investigations in New York and New England.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

Montgomery County lies entirely within the Mohawk Valley physiographic province, but the foothills of the Adirondack Mountain province begin only a few miles to the north and the abrupt escarpment of the Southwestern Plateau and Catskill Mountain provinces border the county immediately to the south (Miller, 1924, fig. 2). The total relief of the county is approximately 1,215 feet, although locally on the uplands above the inner valley of the Mohawk River the relief does not exceed about 500 feet. The highest elevation is 1,450 feet above mean sea level on Oak Ridge near the center of the southern border, and the lowest point is about 235 feet along the Mohawk River as it leaves the county.

Montgomery County is divisible readily into the sharply undulating upland area and the alluvial flats and level terraces along the Mohawk River and Schoharie Creek (pl. 1). The Mohawk River flows from side to side through a steep-walled valley averaging about 1,000 feet in width, and the width of the flood plain on a given side of the river at any place depends upon the position of the river in relation to the valley walls. The flood plain is best developed between Fultonville and Fort Hunter and just west of St. Johnsville. Level terrace surfaces are conspicuous west of Fonda and in the vicinity of Tribes Hill, Auriesville, and St. Johnsville.

Away from the river, the surface rises abruptly 250 to 500 feet in less than a mile to the uplands. Locally, as northeast of Amsterdam, the surface is relatively flat. Generally, however, these areas are moderately to sharply undulating. In the southwestern and southeastern corners and along Schoharie Creek the surface comprises irregularly rounded hills and steep slopes. The remainder includes small level areas scattered about on an undulating surface. The district about Charleston Four Corners is characterized by parallel elongate ridges (drumlins) that trend east-west.

The Mohawk River drains all the surface waters in Montgomery County; some streams enter the river directly, whereas others drain into Schoharie Creek, the principal tributary. The important tributaries of the Mohawk River include North Chuctanunda, Kayaderosseras, Cayadutta, and Caroga Creeks on the north bank, and Terwilleger, South Chuctanunda, Schoharie, Auries, Yatesville, Flat, Canajoharie, and Otsquago Creeks on the south bank.

Streams in Montgomery County generally display a dendritic pattern, although rectilinear or trellis patterns are developed, especially in the south-central portion. Valleys are sharply incised as they approach the major drainage channels, but commonly the valleys are shallow elsewhere. In spite of the large number of streams within the county, some sections are not well drained. Natural lakes or ponds are lacking, but swamps occur at many places on the uplands. The flow in the upland streams fluctuates markedly and many contain little or no water during dry periods. The volumes of water passing stream-gaging stations of the U. S. Geological Survey on the Mohawk River at Little Falls, Herkimer County, and on Schoharie Creek at Burtonsville, Montgomery County, are shown in table 1.

CLIMATE

The climate of this county is of the continental type, characterized by moderately large precipitation, low evaporation, and a wide range in temperature. The summer days generally are rather warm and the nights are comparatively cool. Rarely is the heat oppressive for extended periods. The winters are moderately severe in most years and are accompanied by heavy snowfall.

The average mean annual air temperature at Amsterdam is 45.2 degrees F. and at Canajoharie it is 46.0 degrees F. The highest temperatures occur during June, July, and August, and the lowest in December and January. At Amsterdam the highest recorded temperature is 100 degrees F. and the lowest is —30 degrees F. The average growing season, or the interval between the last killing frost in the spring and the first killing frost in the fall, is about 150 days. Local variation in temperature and precipitation result from the marked differences in elevation and relief within the county, and the length of the growing season is somewhat shorter on the uplands than in the lowlands.

Table 1.—Yearly maximum, minimum, and mean stream flow of the Mohawk River near Little Falls, Herkimer County, and of Schoharie Creek at Burtonsville, Montgomery County. Data from records of the U. S. Geological Survey.

Year	Mohawk River at Little Falls: Flow in second-feet			Schoharie Creek at Burtonsville: Flow in second-feet		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
1934	2,046	14,400	463			
1935	2,901	17,400	970			
1936	2,928	22,400	630			
1937	3,061	14,400	750			
1938	2,756	17,000	676			
1939	2,248	13,100	503			
1940	2,857	22,400	830	1,076	19,400	16
1941	2,145	14,300	507	354	4,990	7.3
1942	2,632	16,900	681	797	16,500	58
1943	3,653	18,500	927	1,309	10,200	14
1944	2,329	13,500	708	571	10,700	17

The mean annual precipitation averages about 40 inches, but slight deviations from the mean occur frequently (fig. 2). In figure 2, B, the shape of the graph rather than the area above or below the normal line is the significant feature, as the position of the curve with respect to normal is controlled largely by conditions at the beginning of the period of record in the graph. At Tribes Hill, the recorded annual precipitation has ranged from a minimum of 26.02 inches in 1930 to a maximum of 45.67 inches in 1945. Precipitation varies only moderately throughout the year at Amsterdam, from about 4 inches in June, the wettest month, to 2.5 inches in January, which normally is the driest month. Slightly less than half the precipitation occurs during the growing season from May through September (fig 3), but normally the precipitation in Montgomery County is adequate in quantity and the distribution is satisfactory for agriculture. Snowfall averages about 60 inches and occurs largely from November through February. On the upland areas the snow is somewhat heavier and persists longer in the spring.

The prevailing wind direction during all months is west at Amsterdam, Canajoharie, and Fort Plain. Sunshiny days outnumber cloudy days in the spring and summer, but the reverse is true in the fall and winter.

POPULATION

The population of Montgomery County was 59,142 according to the 1940 census, and the increase since 1910 is slightly less than 3 percent. Approximately 65 percent of the residents of the county in 1940 lived in urban areas with an average of about 145 people per square mile. Population data for the county, villages and city, and the political subdivisions are shown in table 2. Estimates for 1945 by the New York State Department of Commerce suggest, however, that the population has declined somewhat since 1940.

TRANSPORTATION

The main line of the New York Central Railroad from New York to Chicago follows the north bank of the Mohawk River and passes through Amsterdam, Fonda, Palatine Bridge, and St. Johnsville. The West Shore Railroad, also operated by the New York Central System, runs along the south bank of the river. Hard-surfaced, Federal, State, and County highways furnish excellent access to all sections of the County. The main roads (State Highways 5 and 5S) parallel the Mohawk River, with important lateral branches northward to Johnstown and Broadalbin, and southward to the Cherry Valley turnpike (U. S. Highway 20).

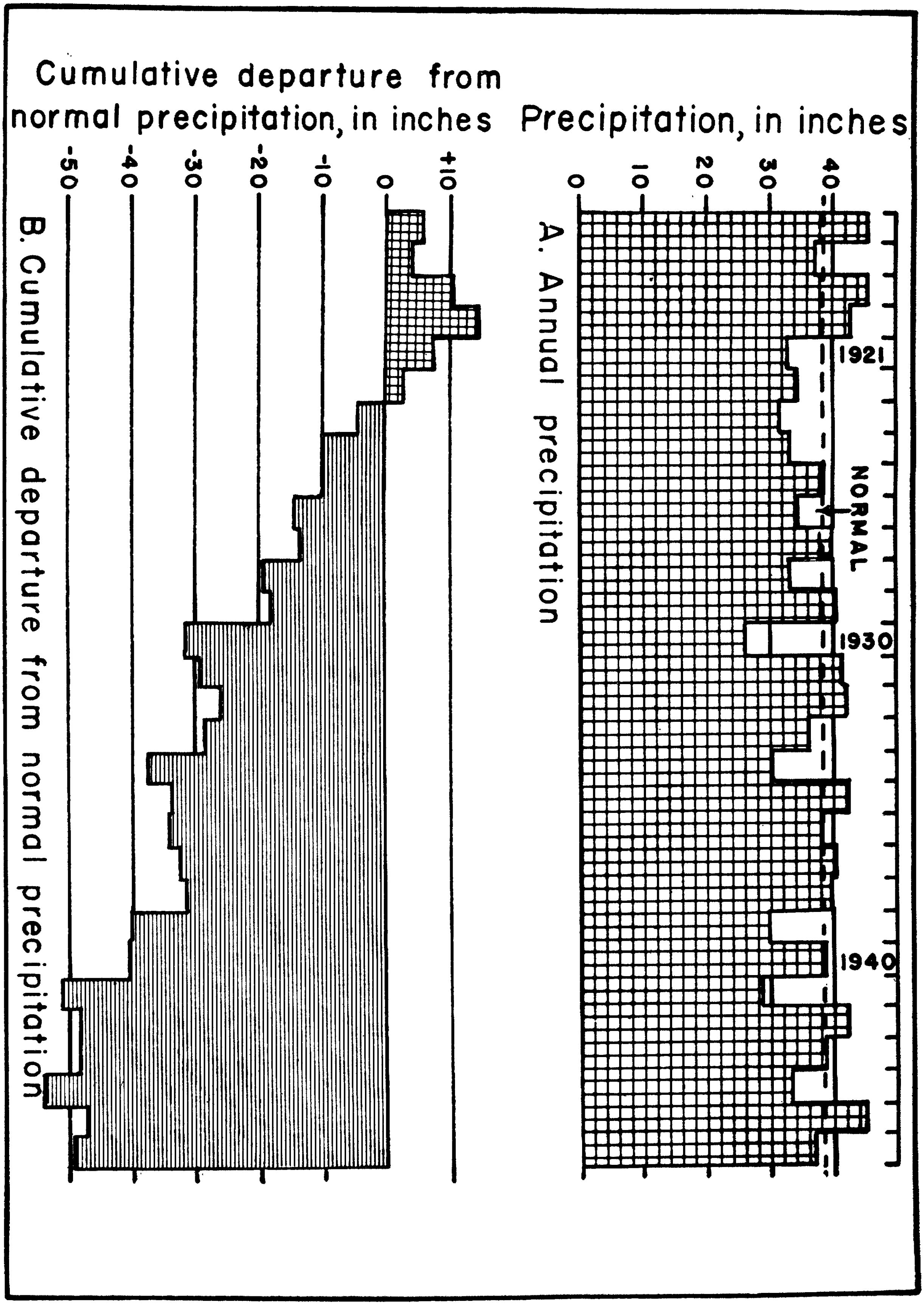

Figure 2.—Precipitation at Tribes Hill, New York 1917-46.

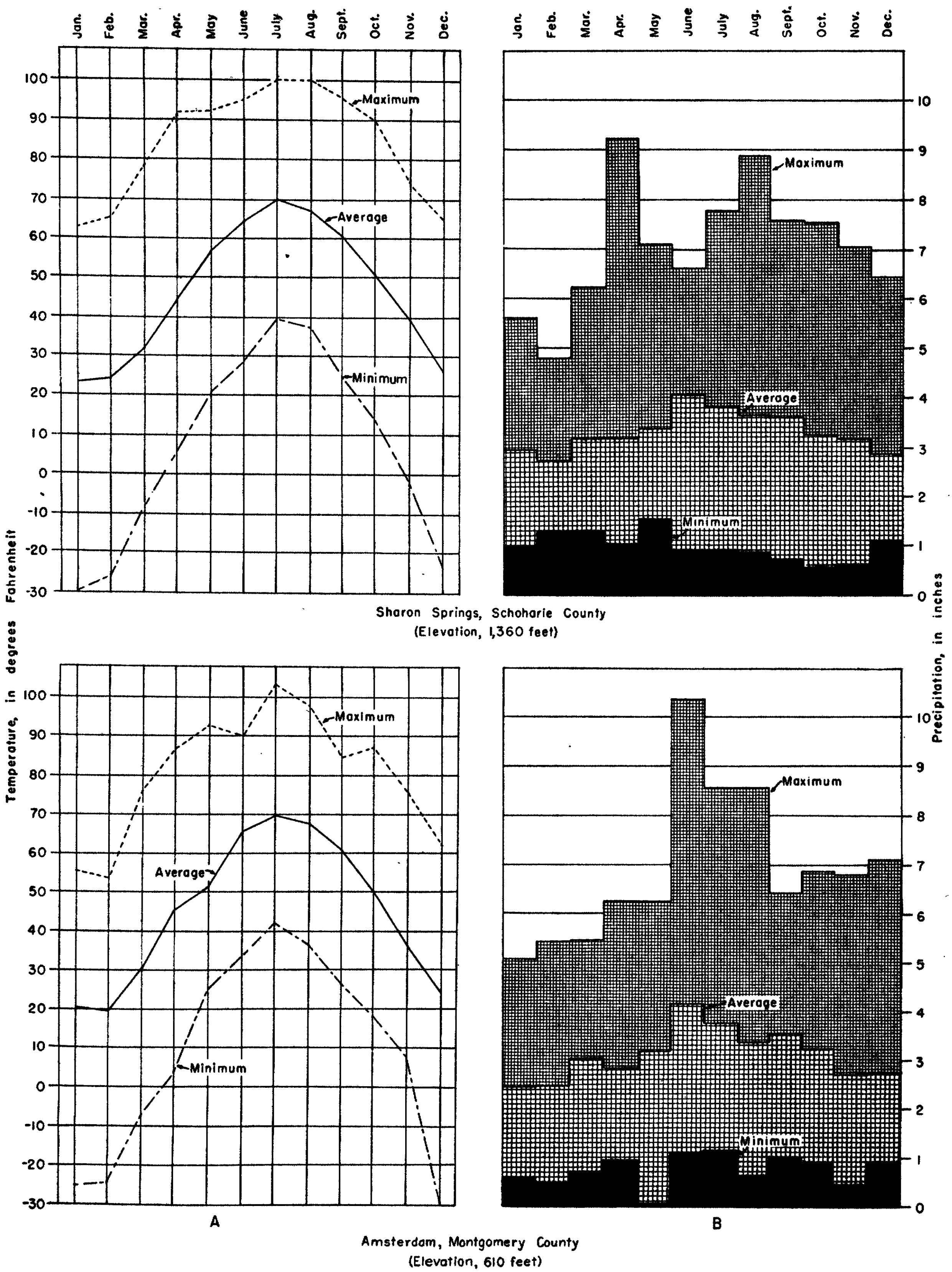

Figure 3.—Graphs showing (A) monthly temperature ranges and (B) monthly precipitation ranges at Amsterdam and Sharon Springs, New York.

Table 2.—Total population in Montgomery County and population in the towns and in urban areas, 1910, 1920, 1930, and 1940. Data from reports of the U. S. Bureau of the Census.

	1910	1920	1930	1940
County, total	57,567	57,928	60,076	59,142
Urban	——	36,271	40,061	38,676
Rural	——	21,657	20,015	20,466
Amsterdam, city	31,267	33,524	34,817	33,329
Amsterdam, town	3,074	3,130	3,818	3,911
Ft. Johnson	600	680	833	868
Hagaman	875	855	867	933
Canajoharie, town	3,889	3,784	4,023	4,062
Ames	——	——	170	180
Canajoharie	2,273	2,415	2,519	2,577
Charleston, town	900	785	494	609
Florida, town	1,904	1,651	1,805	1,848
Glen, town	2,002	1,782	1,749	1,754
Fultonville	812	869	831	806
Minden, town	4,645	4,366	4,232	4,376
Ft. Plain	2,762	2,747	2,725	2,770
Mohawk, town	2,488	2,353	2,730	2,753
Fonda	1,100	1,208	1,170	1,123
Palatine, town	2,517	2,232	2,287	2,420
Nelliston	737	664	553	638
Palatine Bridge	392	443	503	585
Root, town	1.512	1,198	1,021	1,106
St. Johnsville, town	3,369	3,123	3,000	2,974
St. Johnsville	2,536	2,469	2,273	2,283

The New York Barge Canal, successor to the old Erie Canal, follows the Mohawk River across the County and furnishes water transort for some agricultural and industrial products. Excellent facilities for air transportation are furnished by the airport at Fort Plain, which is adequate for large commercial aircraft.

AGRICULTURE

Agriculture is the chief occupation in Montgomery County and about 60 percent of all of the land is in farms. The type of agriculture has changed gradually from the production of numerous crops needed locally to a specialized system under which milk is the principal product (tables 3 and 4). Crops for livestock feed, as hay, barley, oats, and corn for silage, now make up a major part of the tilled acreage, although buckwheat is important locally on the poorer soils. Between 1850 and 1930 the acreage used for agriculture declined 11 percent (Hill and Blanch, 1934), but much of the abandoned farm areas are in regions where crop yields are low. For example, in 1931, 23.2 percent of the land in the town of Charleston had been abandoned as compared with only 3.7 percent in the town of Minden. The New York Conservation Department was reforesting about 10 percent of the county in 1933 and most of this comprised abandoned farm land.

Table 3.—Value of livestock, crops, and forest products sold from Montgomery County, 1929 and 1939. Data from reports of the U. S. Bureau of the Census.

	1929	1939
Milk products except churned butter	$3,297,070	$2,526,302
Butter, churned	80,601	24,531
Wool	3,518	669
Animals butchered on farms, total	——	72,633
Livestock sold alive, total	——	426,827
Poultry raised, total	228,953	152,944
Chicken egg production	332,280	246,211
Honey produced	26,585	11,185
Cereal grains	464,383	343,580
Hay and forage	1,499,026	1,499,796
Irish and sweet potatoes	68,516	35,166
Fruits and nuts	103,291	37,387
All crops harvested, total	2,324,107	2,045,578
Forest products, total	——	10,692

Table 4.—Acreage of crops grown in Montgomery County, 1844, 1874, 1899, 1931, and 1946. Data for 1946 furnished by Seeber's Lane Grange, no. 1193; other data from Hill and Blanch (1934).

	1844	1874	1899	1931	1946
Hay	——	87,903	84,621	67,159	72,000
Oats	34,187	25,356	26,640		
Barley	10,917	1,036	628	21,564	15,000
Buckwheat	7,050	5,809	5,028	5,718	
Rye	8,787	579	1,097	39	6,000
Wheat	6,979	3,561	1,224	425	
Flax	4,382	——	2	——	——
Corn, for grain	9,455	7,644	11,449	981	
Corn, for silage	——	——	——	14,966	1,500
Peas	4,850	339	104	——	——
Other crops	——	——	——	——	10,000

INDUSTRY

Industry generally is concentrated in the more populated centers, although a large proportion of the employees live in rural areas. Milk-processing plants are scattered throughout the county and at least one plant is located in each of the larger villages.

Several plants in Amsterdam produce a large proportion of the Nation's output of rugs, carpets, brooms, whisk brooms, and fresh-water-pearl buttons. Other important manufactured articles include gloves, linseed oil, clothing, beverages, paints, varnish, piece goods, and novelties (table 5). Canajoharie is the site of the important Beech-Nut Packing Co., which ships large quantities of preserved food products. Manufacturing is carried on to a lesser extent in Fonda and Fort Plain. The New York Power and Light Corp., a part of the interconnected Niagara Hudson Power System, operates a modern 60,000-horsepower steam electric-generating plant just below Amsterdam.

Table 5.—Manufacturing establishments in Montgomery County, 1939. Data from New York State Department of Commerce.

Industry	Number
Food and kindred products	36
Textile-mill products and other fiber manufactures	19
Apparel and other finished products made from fabrics and similar materials	15
Printing, publishing, and allied industries	9
Paper and allied products	5
Chemical and allied products	4
Furniture and finished lumber products	3
Iron and steel and their products, except machinery	3
Machinery, except electrical	3
Leather and leather products	2
Nonferrous metals and their products	1
Lumber and timber basic products	1
Miscellaneous industries	7
Number of establishments	108
Number of wage earners, average for year	11,649
Wages, total for year	$11,115,000
Value added by manufacture	31,059,000
Value of products	55,704,000

NATURAL RESOURCES

Although agriculture and industry make up a large part of the economy in Montgomery County, local natural resources play an important supporting role. The importance of fertile soil to agriculture is apparent readily, and the resources of ground water are considered later in this report. Sand and gravel are produced for road-surfacing and building purposes at numerous locations throughout the county, and large supplies are available in the terrace deposits scattered along the Mohawk River. Limestone is quarried for similar use rather extensively at Palatine Bridge and southeast of Amsterdam. Local limestones were used formerly for building stone and in the construction of the old Erie Canal, but these quarries now are abandoned. The Little Falls dolomite and the Tribes Hill and Lowville limestones are relatively pure thick-bedded rocks that may be quarried to yield a good crushed rock. The Amsterdam and Glens Falls limestones, as a whole, are too impure for this use, but together with the Lowville limestone and the thinly bedded upper part of the Tribes Hill limestone they have been used as building stones. These rocks are quarried easily and seem to resist weathering satisfactorily where used in buildings and other structures. Placement of the blocks on edge, however, results in relatively rapid disintegration.

Exploration for oil and gas has been carried on in the county, but drilling has not yielded these substances in commercial quantities. A well was drilled into the Potsdam sandstone at a depth of 1,556 feet in 1933 near Glen without encountering evidence of oil or gas. A well at Palatine Bridge was drilled to either the Potsdam sandstone or the lower part of the Little Falls dolomite at a depth of 800 feet, also without success. Shows of gas were encountered, however, at depths of 170, 475, and 575 feet. The well was plugged back to 625 feet and is now used for the public supply of Palatine Bridge, obtaining water from the Little Falls dolomite. A deep well at Randall is reported reliably to have produced sufficient gas to supply a home for 2 years, and well Mt 246 at Randall now produces noticeable amounts of natural gas with the water. Although drilling has been largely unsuccessful, the reported occurrences of gas and the abundant petroliferous residue obtained by treatment of the Ordovician limestones with acid suggest that continued exploration of the stratigraphic trap formed by the pinching out of the Potsdam sandstone and other formations in the vicinity of Canajoharie may be rewarded by a measure of success.

GEOLOGY

SUMMARY OF STRATIGRAPHY

The rocks of Montgomery County comprise three major units—old metamorphic rocks, consolidated sedimentary layers, and surficial unconsolidated materials. The oldest rocks include water-deposited sediments that have been greatly modified to crystalline schists and gneisses. Following an extensive period of structural deformation and erosion, thick lower Paleozoic sedimentary formations were deposited over the county. The lithology of these rocks changes gradually from sandstone at the base through dolomites and limestones to black shale and sandstone above. These formations have been compacted and cemented to form relatively resistant layers, but they have not undergone the intensive metamorphism seen in the basement complex. Unconsolidated deposits of clay, sand, gravel, and till of Pleistocene age, together with Recent alluvium, now cover much of the surface of the county.

All the rocks that occur below the surface in the county can be seen at the surface within the county or in nearby counties. The distribution of the Paleozoic rocks at the surface or beneath the drift is a consequence of differential erosion of strata that dip gently and that have been displaced along several major faults. The character and groundwater supply of the geologic formations in this area are described later in the section on Water-bearing formations.

GEOLOGIC HISTORY

No single small area provides a complete record of its history, but commonly data may be obtained from more complete records preserved in the surrounding area. Thus, the following review of geologic events is based on evidence observed in the rocks of Montgomery

County, supplemented by pertinent data noted by other geologists in the surrounding districts (Miller, 1924; Goldring, 1931).

Pre-Cambrian Rocks

The earliest known geologic feature was the deposition of thick sedimentary strata. Subsequently during periods of mountain formation these deposits underwent metamorphism to crystalline schists and banded gneisses and were intruded by igneous rocks. Uplift in the latter part of pre-Cambrian time resulted in removal of several thousand feet of rock by erosion as the region was reduced toward base level.

Paleozoic Era

The Paleozoic began with a continuation of the previous erosion which culminated in a relatively level surface that seems to have had a local relief of about 100 feet throughout most of New York State. Late in Cambrian time shallow seas encroached from the east toward the west, surrounding the Adirondacks and depositing the Potsdam sandstone. As the seas deepened, the clastic sediments were gradually replaced by calcareous materials that form the dolomitic limestone of the more extensive Little Falls dolomite. This period of deposition was ended by a marked uplift and by erosion of the upper surface of the Little Falls dolomite.

The Ordovician period began with subsidence and deposition of the Tribes Hill limestone and continued with deposition of the Lowville, Amsterdam, and Glens Falls limestones. Minor periods of uplift or retreats of the seas permitted slight erosion before and after deposition of the Lowville limestone. Overlying Ordovician strata include chiefly the black Canajoharie and Utica shales and the somewhat more sandy Schenectady formation, and possibly the Franfort shale.

Younger Paleozoic rocks of Silurian and Devonian age undoubtedly extended across Montgomery County. During late Paleozoic time, however, the seas withdrew from this part of the State and many of the older rocks were removed.

Mesozoic and Cenozoic Eras

All Mesozoic and most of Cenozoic time is not represented by deposits in the Mohawk Valley region, so that information as to geologic conditions is inferred largely from studies in other regions. It is evident that the Mesozoic was a long interval of erosion which resulted in the development of the Kittatinny peneplain throughout the northern Appalachian region and eastern Canada. At the close of the Mesozoic, the region was warped and uplifted, probably about 1,500 feet, so that Tertiary time was again a period of extensive erosion. Valleys were cut into the former peneplain but the intervening divides were lowered only slightly. At about the same time displacement occurred along faults so as to cause additional distortion of the peneplain surface.

Most of the major features of drainage and topography were well established in the Tertiary. Erosion had only partly reduced the surface when additional uplift occurred in the late Tertiary. Rapid erosion began again but soon was halted by the Pleistocene glaciation. Montgomery County presumably underwent several intervals of glaciation, but deposits of pre-Wisconsin ice advances have not been identified in this vicinity.

As the glacial ice moved southward, lower regions along the present Champlain Valley and west of the Adirondacks facilitated rapid movement of the ice, whereas the Adirondack Mountains temporarily blocked the advance. Thus, tongues of ice moved westward up the Mohawk Valley from the Hudson lobe and eastward from the Ontario lobe (Brigham, 1929). During the period of maximum ice advance all of east-central New York seems to have been covered, but again during waning stages, ice persisted in the Mohawk Valley after the surrounding higher areas were uncovered.

Prior to the period of glaciation, the Mohawk River had its headwaters at a divide located at Little Falls, Herkimer County, but the diversion of northward-draining streams by the waning ice sheet forced great concentrations of water from the Great Lakes region into the Mohawk Valley drainageway. This resulted in a gradual reduction of the divide and the establishment of the present course of the Mohawk River. The numerous terrace and deltaic

deposits along the Mohawk Valley at Yosts, Tribes Hill, and at other places resulted from temporary lakes into which swollen streams poured large quantities of rock debris. Temporary lakes of this nature formed at several levels along the Mohawk Valley when drainage was impeded by ice and also on the northward-flowing tributaries where till deposits blocked preglacial channels. The history of the glacial waters in the Mohawk Valley are given in considerable detail by Fairchild (1912) and Brigham (1898 and 1929), and their reports should be consulted for specific data.

In general the broad Mohawk Valley trench owes its existence to the easily eroded Ordovician shales which were removed by streams flowing along the contact of the hard crystalline rocks of the Adirondacks and the softer Paleozoic formations. Glacial action during the Pleistocene did not change the major topographic features but merely rounded off irregularities and deposited thick accumulations of drift in valleys, and depressions so that a considerable modification of the local drainage resulted.

STRUCTURAL GEOLOGY

The prominent northeast-trending ridges of the Mohawk Valley region and the conspicuous constructions of the valley, as at the Noses near Yosts, result from displacement of segments of the rock formations along several high-angle normal faults (pl. 2). These faults have not been traced south of the Mohawk River, where the surficial covering of till and the uniform character of the shales makes their identification difficult, but they extend some 30 miles northward into the Adirondacks. The vertical displacement along the Noses fault, which is one of the largest, is approximately 500 feet, with the downthrown side to the east. Erosion subsequent to faulting usually has exposed the resistant Little Falls dolomite or even the crystalline Grenville series on the west or upthrown side, whereas the less resistant Canajoharie and Utica shales lie in low broad areas to the east. Hence, the faults north of the Mohawk River are marked by high scarps or cliffs.

The exact time of the faulting has not been determined, but seemingly it resulted from tensional stresses that occurred during or following the Taconic disturbances to the east (Megathlin, 1938; Kay, 1942).

The Adirondack axis comprises an inconspicuous topographic feature at the present time, but it is a structure that bears importantly on the distribution of the Cambrian and Ordovician formations in Montgomery County. This northeast-trending axis, passing between Canajoharie and Sprakers, existed during the Ordovician as a low barrier which separated, to a greater or lesser degree, the basins to the east and west (Kay, 1937, 1942). As indicated later in the discussion of the water-bearing formations, the Lowville, Amsterdam, and Glens Falls limestones successively thin and pinch out westward on the flank of the Adirondack axis, to reappear in somewhat modified form again in the vicinity of St. Johnsville.

GROUND WATER

SOURCE

Water that flows from wells and springs or can be pumped from wells is known as *ground water*. Most of the ground water in Montgomery County is derived from that small part of the local precipitation that percolates into the ground. The water in most shallow wells and springs is that which fell on the surface nearby, but water from the deep artesian wells may have migrated through water-bearing formations several miles from the outcrops of the formations. An inch of water falling on 1 square mile amounts to more than 17,000,000 gallons; thus nearly 700,000,000 gallons is received by each square mile where the precipitation is 40 inches a year. Only a small percentage of the total local precipitation, therefore, is required to keep most of the water-bearing strata filled. The water, once it reaches a water-bearing formation, percolates slowly to areas of discharge—it flows from springs, seeps into streams, is evaporated where the water table is shallow, or is withdrawn from wells.

OCCURRENCE

The amount of ground water that is contained by rocks below the surface depends upon the characteristics of the interstices or openings in the rocks (fig. 4). The size, number,

shape, and arrangement of these interstices differs in each of the many types of rock; thus local occurrence of ground water is dependent upon the geology. The number and size of interstices in a rock determine its *porosity,* or the percentage of the volume of the rock that is occupied by openings. A rock is saturated when all the pores are filled. If the interstices are not interconnected or are very small, as in a clay, the rock may be saturated but will not yield appreciable amounts of water to wells. The *permeability,* or capacity for transmitting fluids under pressure is, therefore, an important factor in determining the water-bearing property of a rock.

The permeability of the rocks of Montgomery County depends to a large extent on the lithology. The unconsolidated materials that were deposited by streams or in ponded bodies of water following the retreat of the continental ice sheet comprise relatively distinct beds of clay, silt, sand, and gravel. The moderately well sorted gravels have a relatively high permeability and yield comparatively large quantities of water.

Sandstone, which is more or less firmly cemented beds of sand, differs in permeability according to the difference in size and assortment of the grains and the amount and character of the cementing material. The beds of limestone and dolomite are relatively impervious except for fractures and solution openings. As these rocks are comparatively soluble in water that contains common dissolved gases, especially carbon dioxide, fractures and openings along bedding planes are enlarged readily to channels. Thus, the permeability differs greatly and somewhat erratically from place to place, and the yield of wells depends upon the number and size of the water-bearing openings that are encountered. Shale, which is largely indurated clay, contains such small pore openings that it yields little water to wells, except from open bedding planes and joints in shales that are sufficiently indurated to support such openings.

MOVEMENT AND STORAGE

Water below the land surface is divisible into two general types: the suspended water that has seeped into the *zone of aeration* in the soil and rock near the surface, and water in the subjacent *zone of saturation,* or ground water (fig. 4). In the zone of aeration, percolation of water is mainly downward, whereas in the zone of saturation it is dominantly lateral. Some of the water in the zone of aeration percolates downward to the zone of saturation, where the pores and other openings in the rock and rock material are filled completely with water. Springs and wells are supplied by water from this lower zone. The surface separating the zone of saturation from the zone of aeration is called the *water table.* Any rock below the surface of the earth that is saturated with water and is sufficiently permeable to yield this water to springs and wells is called an *aquifer.*

Wells that obtain water from aquifers that are not separated from the water table by relatively impermeable beds—that is, aquifers having a water table—are termed *water-table* wells. Many of the deeper wells encounter water in a completely saturated bed that is beneath an impermeable layer, so that the water has sufficient pressure head to rise to a level above the bottom of the confining bed. These wells are called *artesian wells* whether or not the water flows at the surface. The hydrologic properties of water-table and artesian aquifers differ importantly, so that their recognition is essential. The surface to which artesian water will rise under its full head is called the *piezometric surface.*

Water-bearing materials rarely are perfectly homogeneous but generally they occur in layers of differing permeabilities. Many beds are not continuous, but thin laterally or are replaced by materials of a different character. Thus, local impermeable beds of limited extent may occur in the zone of aeration, and a body of ground water may be "perched" on such a local layer, below which are unsaturated permeable materials above the main or regional water table. The upper surface of such a perched body of subterranean water is called a *perched water table.*

FLUCTUATION OF GROUND-WATER LEVELS

The water table or piezometric surface is not stationary or static, but fluctuates like the water surface of lakes and surface reservoirs. It rises when water is added to the subterranean reservoirs and falls when withdrawal exceeds inflow. The amount of local precipitation is the most important factor affecting the level of water in wells that are not affected by pumping (see fig. 5) but its effect may be modified by other conditions such as the retarding

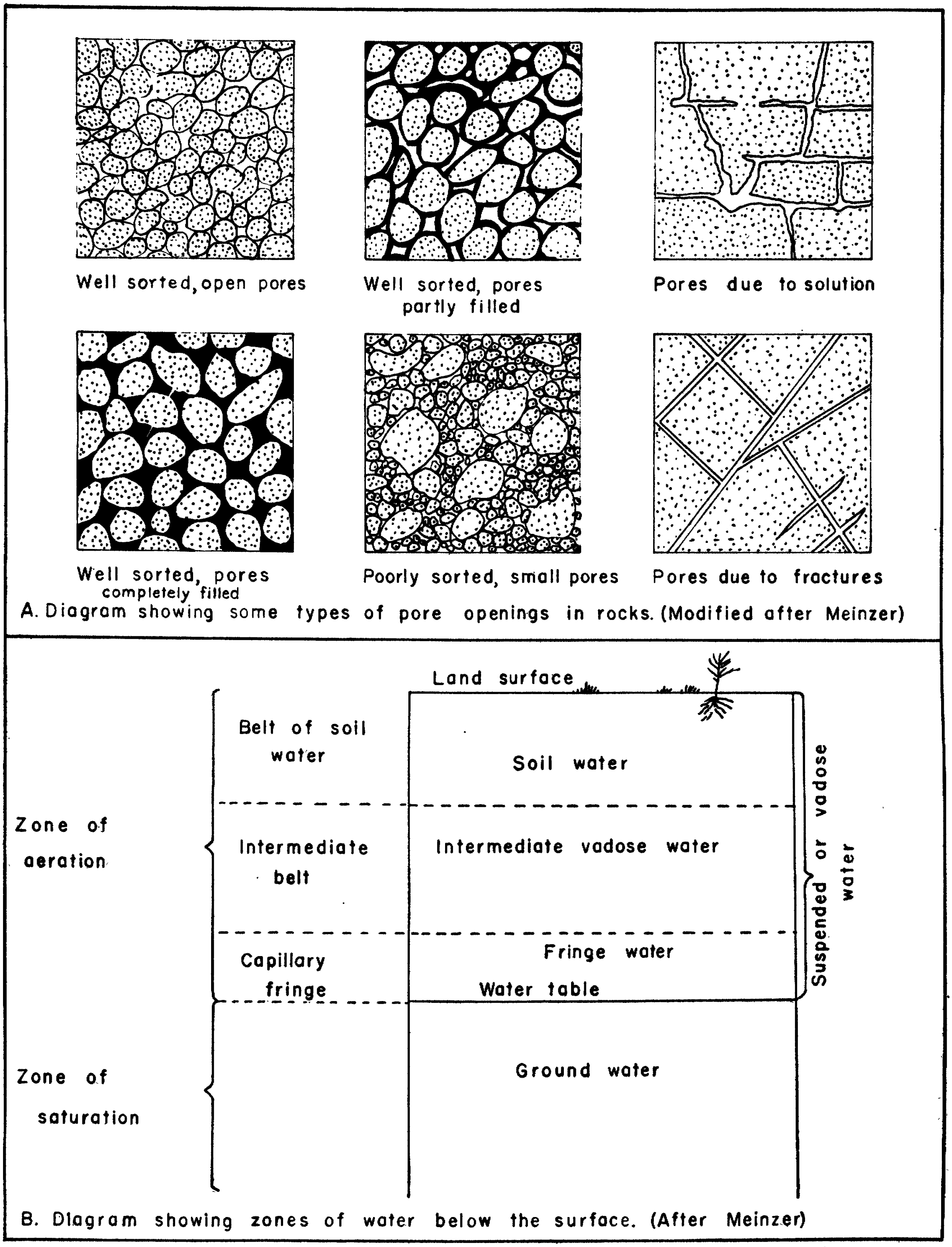

Figure 4.—Diagrams showing pore spaces in rocks and zones of water.

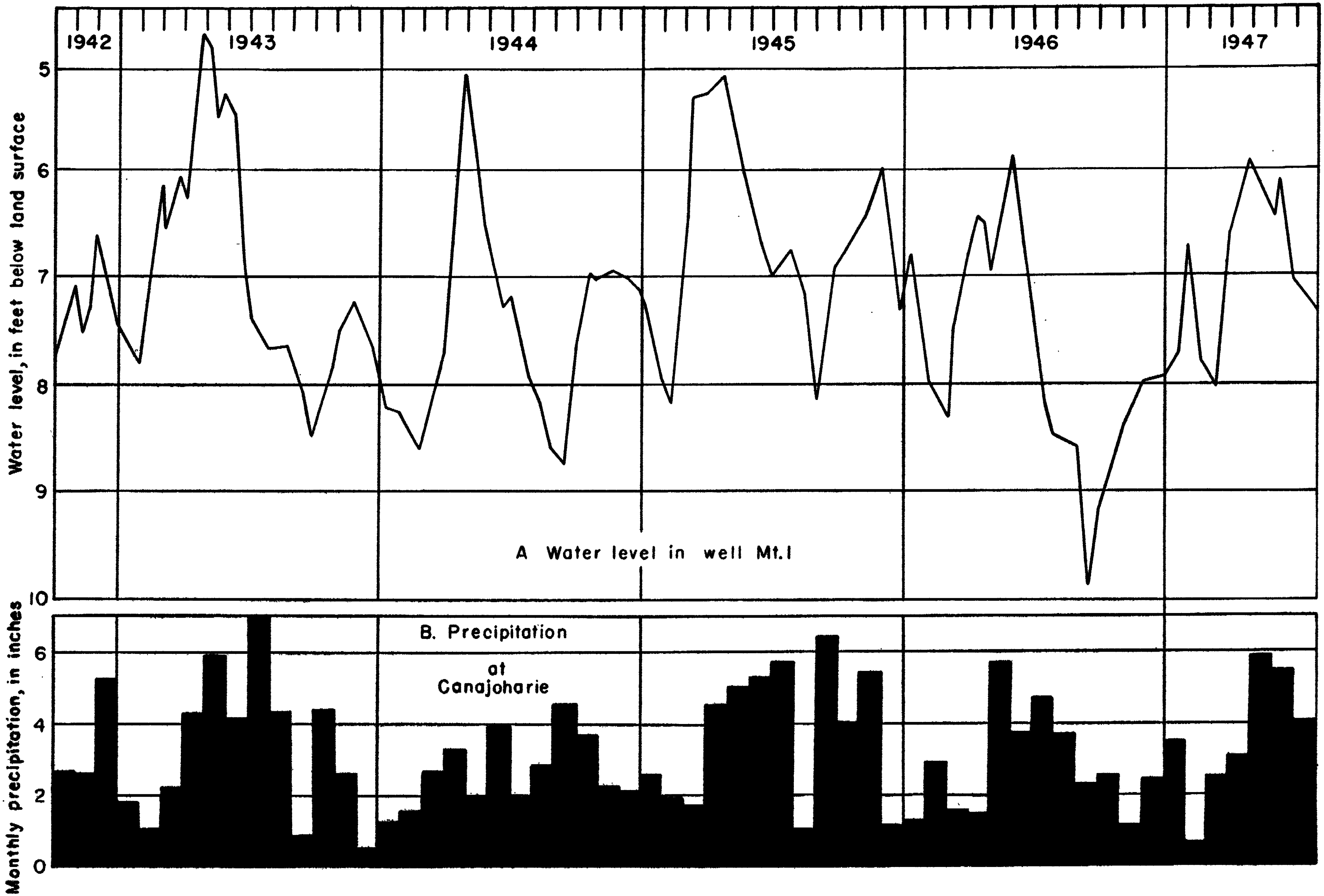

Figure 5.—Hydrograph showing water level in well Mt 1 and monthly precipitation at Canajoharie.

of downward percolation because of frozen ground or the capture of the water for plant use or to replenish depleted soil moisture. Figure 5 shows that a large part of the precipitation received in the summer is evaporated or used by plants; little of it reaches the water table, which declines until the end of the growing season. Shallow water-table wells respond rapidly to periods of rainfall but the deeper wells and those in artesian aquifers respond more slowly. The water table or piezometric surface near areas of pumping is drawn down so that water may flow to the wells but generally rises again when pumping ceases or is reduced.

Water levels in wells are continuous with the water table outside the well, or in artesian wells represent the piezometric surface. The character and magnitude of the water-level fluctuations, therefore, may be determined from periodic measurements in observation wells. These fluctuations of the water table indicate the recharge and discharge of the ground-water reservoirs in much the same manner as changes in the water level in surface reservoirs indicate changes in storage. Analysis of the water-level fluctuations and other data permits determination as to whether the safe yield of ground-water reservoirs is being exceeded.

Weekly measurements of water level in well Mt 1, which is northwest of St. Johnsville, are shown in figure 5 together with monthly precipitation at Canajoharie. The water level in this well fluctuates several feet during a year, going from a high level in the spring to a low stage in the early autumn. The minor rise during the late autumn seems to be due to a reduction in evaporation and transpiration from vegetation after frosts. After the autumn rise the water level declines to a low stage early in the next year, as a result of continuing natural or artificial discharge and of lack of recharge because of frozen ground or the persistence of precipitation as a snow cover. Then, during the spring, the frost and snow melt and a part of the water, together with a part of the spring rainfall, percolates to the water table and raises it to the highest stage of the year.

GROUND-WATER RECHARGE

The addition of water to the subterranean reservoirs is known as *ground-water recharge*. Most of the ground water in Montgomery County is derived from local precipitation, although the water may have moved through the aquifers for a considerable distance from the intake areas. The average annual precipitation as rain or snow in the county is about 40 inches. Part of this water flows off rapidly as surface runoff, part is evaporated directly, part is evaporated (transpired) from plants, and part sinks down to the zone of saturation to recharge the subterranean reservoirs.

The quantity of water that seeps down to the zone of saturation depends upon the intensity and quantity of the rainfall, the amount and type of vegetation, the slope of the surface, the permeability of the soil and underlying materials, and other factors. These features differ importantly over the county, so that the amount of water that recharges the water-bearing formations differs from place to place. The amount at any particular place can be determined only by means of intensive investigations.

Normally, the streams of Montgomery County receive water from the adjacent permeable sediments toward which the water table slopes. Rapid rises in river stage, however, may bring the river level above the water table and allow large quantities of water to enter adjacent permeable deposits. Much of this water subsequently drains back into the surface stream. Where water can move into or out from the water-bearing formations along a stream, heavy withdrawals of water from adjacent wells may lower the water table so that river water recharges the aquifer during much of the year (Jeffords, 1945). Rises in pool stage of the Mohawk River that accompanied construction of the Barge Canal doubtless raised water levels in the adjacent sand and gravel deposits. Wells within a short distance of the Mohawk River and drawing water from the sands and gravels that border the river may yield water which has entered from the river. For example, it is reported that the concentration of chloride in water from such a well at Canajoharie increased greatly for a short period following the sinking of a barge loaded with salt in the river nearby.

The selection of a well site near a river bank, however, does not insure recharge from the stream, for impermeable material may lie between the river and the aquifer. Where large amounts of water are desired, it may be desirable to locate properly designed wells where the hydrologic evidence shows that they will obtain recharge from a surface stream as well as from local precipitation.

Artificial recharge of ground-water supplies has received little attention in the county, and at the present time does not seem to be necessary. As the use of large quantities of ground water for air conditioning and cooling purposes increases in the urban centers, water levels and yields of wells may decline seriously. At such a time the supplies available for warm-weather use may be increased importantly by recharging the water-bearing formation during the winter with cool filtered water from streams, or from the public-supply system where it is obtained from a stream.

GROUND-WATER DISCHARGE

Under natural conditions, the annual discharge of ground water is approximately equal to the annual recharge. Some ground water is evaporated directly into the atmosphere where the water table is shallow. The amount of water lost by evaporation and transpiration varies according to the depth to the water table, type of vegetation, character of the soil, and the season of the year. The bulk of the water that is added by replenishment from rain and snow is discharged from seeps and springs, and this discharge, representing overflow from the ground-water reservoirs, sustains the flow of streams in periods of fair weather.

Withdrawal of water from wells comprises an artificial discharge and generally results in an equivalent decrease in natural discharge or an increase in recharge or both. Under favorable conditions and with moderate pumping rates, this artificial discharge will be compensated for without serious depletion of the reservoirs. Locally, the recharge may be inadequate to furnish the water supplies that are withdrawn from the rocks in these places, so that ground-water reserves are being used up and the water levels are declining. Great and persistent lowering of the water levels in wells may be an indication of serious depletion of the available supply. In any pumped area, however, there is some initial withdrawal of water from storage as the water levels are lowered sufficiently to induce the water to flow toward the wells.

RECOVERY OF GROUND WATER

Principles of Recovery from Wells

The site, method of construction, and type of pump can be determined most readily by application of the general principles of recovery of ground water to local conditions. A site should be decided upon after consideration of the local occurrence of water as may be inferred from records of nearby wells, exposed rocks, and topographic features. Convenience and possible sources of pollution may also bear importantly on the location. In general, wells to obtain water from alluvial valley deposits should be located at a distance from the valley walls, and dug wells in upland areas should be located in thick deposits of soil and mantle rock generally in local depressions, where they will drain the greatest possible area. The occurrence of water in the deeper consolidated rock formations depends upon local conditions of geologic structure and stratigraphy; these factors commonly are not reflected in local topographic features. Where the cost of the water-supply system is sufficiently great, test wells to determine the character and yield of the rocks are of value in preventing costly failures.

When water is pumped from a well, the difference in head between the water inside the well and in the material surrounding it causes water to flow into the well. Thus, the water table or piezometric surface about a discharging well has the general form of an inverted cone with the apex or lowest point at the well. This *cone of depression* lowers the water level in nearby wells and is a determining factor in the spacing of wells. In artesian wells a dewatered cone generally is not formed within the aquifer, but the piezometric surface, or level to which water will rise in unobstructed wells tightly cased is drawn down in a similar manner. The drawdown in a well and the extent of the cone of depression depend upon the permeability of the water-bearing material and its saturated thickness, the quantity of water withdrawn, the proximity of areas of recharge, the duration of discharge, and other factors. Inasmuch as the hydrologic characters of aquifers differ widely, the yield, drawdown, and extent of influence of particular wells are difficult to evaluate without adequately planned and interpreted pumping tests.

The *specific capacity* of a well, which is the rate of discharge for each unit of drawdown, is expressed usually as gallons a minute for each foot of drawdown. The specific capacity of wells differs greatly but generally is much larger for the wells in coarse unconsolidated materials than for wells in the consolidated formations. Wells in medium or coarse gravel may have specific capacities ranging from 10 to 100 gallons a minute or more per foot of drawdown. On the other hand, well Mt 116 in Amsterdam, penetrating the Little Falls dolomite, is reported to have a yield of 40 gallons a minute with an 80-foot drawdown. The specific capacity of this well therefore is about 0.5 gallon a minute for each foot of drawdown. As the cone of depression expands, water must move an increasing distance to reach the well. Initial yields or those immediately after a period of rest, therefore, will be greater than those obtained during continuous operation. Pumping must be continued until the water level in wells becomes essentially stationary for a uniform rate of withdrawal in order to obtain useful data on the specific capacity (see fig. 6).

Relatively accurate methods have been developed for determining the capacities of aquifers to transmit and to yield water to wells (Theis, 1935; Wenzel, 1942; Cooper and Jacob, 1946). The basic properties determined by means of pumping tests and used for predicting the effect of future pumping are the coefficients of transmissibility and storage. The coefficient of transmissibility is generally expressed, for field use, as the number of gallons of water a day that will flow across a section of an aquifer 1 mile wide under a hydraulic gradient (slope of water table or piezometric surface) of 1 foot per mile, at the prevailing storage. The coefficient of storage, which for water-table conditions is essentially equal to the specific yield or "effective porosity", is expressed as the amount of water, in cubic feet, released from storage in a vertical prism of the aquifer with a basal area of 1 square foot when the water level is lowered 1 foot.

As shown in figure 6, the drawdown, and consequently the yield, of wells differs greatly in accordance with the hydrologic properties of the water-bearing formation. Thus, for example, drawdowns in relatively productive water-bearing formations will be small more than a few hundred feet from pumped wells. Drawdowns in less productive formations, however, may be considerable at a distance of a thousand feet or more when the same quantity of water is withdrawn (see fig. 6, A). Adequate information on the hydrologic properties of water-bearing formations, therefore, is essential to estimate satisfactorily the maximum safe yield of wells, the most economical spacing of wells, and the desirable size of the pumping equipment.

The many factors involved in the location, construction, and development of wells makes it advisable to employ reliable well drillers who know local conditions and utilize modern methods of construction. A record should be made of the static and pumping level of the water and other data obtained during an adequate pumping test, and of the materials encountered during drilling. These data aid in the selection of suitable screens, permit exclusion of water of undesirable quality, and serves as a guide for future repairs or additional drilling.

Dug Wells

Dug wells are the type of well most widely used in Montgomery County for rural water supply. They are cheaper than drilled wells because they are shallower and require only unskilled labor and inexpensive equipment. Dug wells commonly are 2-½ to 4-feet in diameter and are curbed with native stone, brick, concrete blocks, or tile. They are generally practicable only in areas in which there is a shallow water table in unconsolidated materials that do not cave readily. The large diameter of dug wells is advantageous in obtaining water from a poor water-bearing formation because of the large infiltration area and the large stored supply that is immediately available for use. Where the unconsolidated materials are too thin, the water table fluctuates widely in response to variations in local precipitation and dug wells are likely to go dry in periods of drought. Dug wells commonly do not yield large supplies of water, and also they are difficult to protect against bacterial contamination.

Driven Wells

In areas underlain by unconsolidated sand and gravel, in which the water table is at shallow depth as near Tribes Hill, driven wells may be adequate for small supplies. These wells are constructed by driving down a string of 1¼ to 3-inch pipe at the end of which is

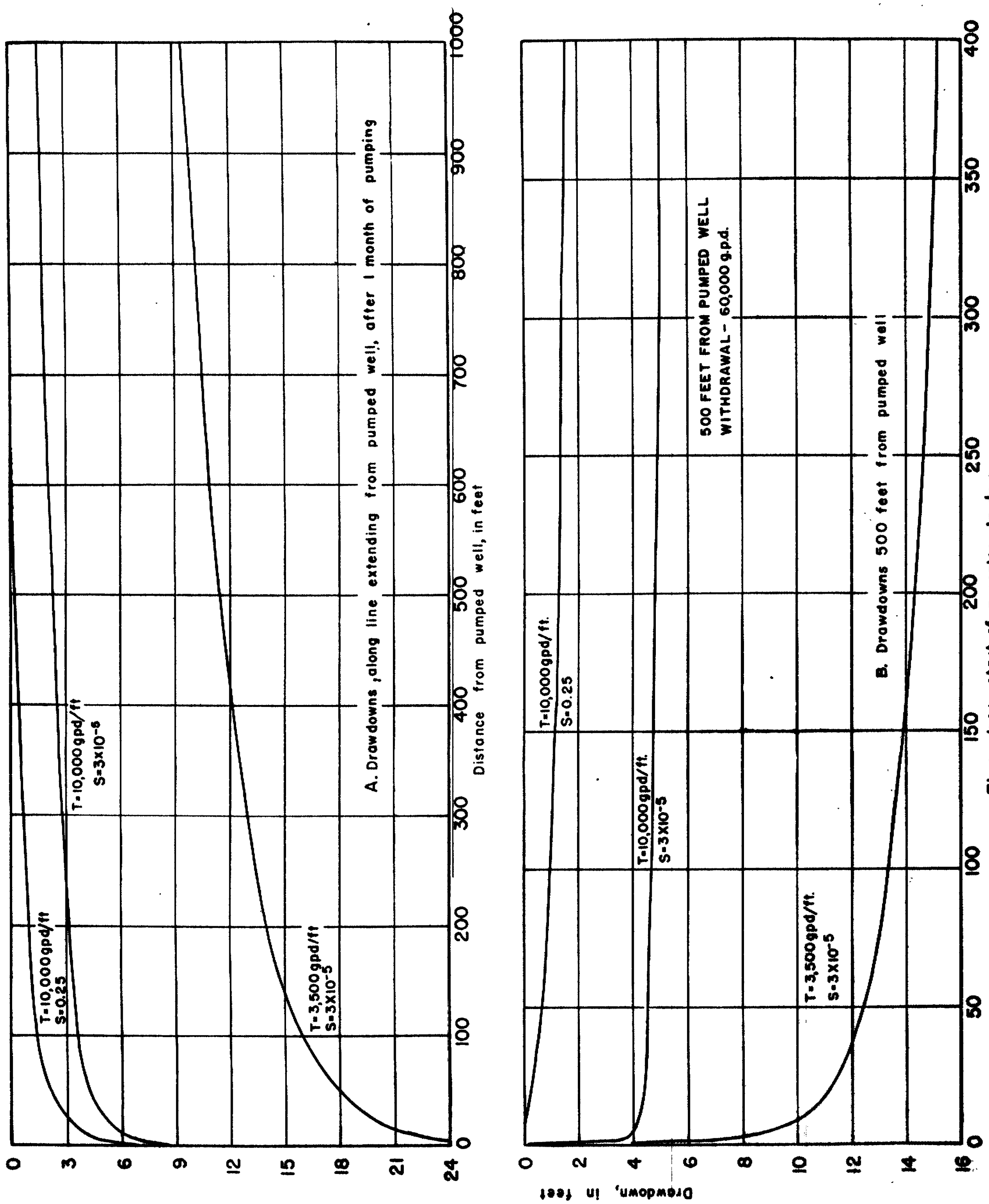

Figure 6.—Graphs showing theoretical drawdowns in aquifers having different coefficients of storage and transmissibility.

attached a screened drive point. Wells may be driven to shallow depths by means of a maul, or to greater depths and in more resistant material by alternately raising and dropping a heavy weight by hand or by engine power. The depth to which wells may be driven is limited by the resistance of the material, the friction on the pipe, and the chance occurrence of large boulders. Under favorable conditions 2-inch wells can be driven 100 feet or more in sand and gravel. Although the yield of individual wells is not great, the ease with which they are constructed and removed makes driven wells very useful for small domestic and stock use, for observation wells, for testing shallow aquifers, and for development of temporary water supplies. Installed in batteries and pumped with a suction pump, they may be used for industrial purposes.

Drilled Wells

These are the best type of well available for obtaining water from consolidated rock and some types of unconsolidated materials existing in the county. These wells are constructed largely by means of small portable percussion or cable-tool drill rigs that alternately lift and drop a heavy drill bit that is suspended by a rope or cable. The bit crushes the harder rocks and mixes these and fragments of softer rock with water in the hole so that the cuttings can be removed periodically with a sand pump or bailer. Wells drilled into consolidated rocks are cased generally only to the top of the rock unless it is desired to shut off unsatisfactory water at greater depths.

Wells in unconsolidated alluvium may be drilled in a similar manner, but more commonly the practice is followed of alternately driving the casing a few feet and then removing the material by bailing. These wells are cased throughout their depth and may have screens at the bottom or the bottom may simply be left open. The yield of wells in unconsolidated sediments generally may be increased considerably by the use of carefully selected screen or slotted pipe, or by perforating the casing opposite the water-bearing bed. Such wells should be bailed or pumped heavily during development so as to remove fine materials that can pass through the openings.

Gravel-packed wells, which are especially adapted to fine-grained aquifers, may be useful in developing large amounts of water from unconsolidated gravel and sand. A large-diameter casing, generally 24 to 48 inches in diameter, is sunk to the top of the consolidated rock formations, and the materials within it are removed. A screen and an attached 12-to 24-inch well casing is lowered inside. The space between these casings is filled with carefully selected gravel, and the outside casing is raised gradually to the top of the water-bearing material or removed entirely. The wells are pumped heavily at first so that fine material about the screen is removed and replaced by gravel, thus increasing the effective diameter and intake area of the well and forming a filter to prevent fine sand from entering the well.

Springs

Springs are natural openings from which ground water is discharged. Some springs are used for water supply in the county even though the flow of many declines considerably during droughts. Many springs occur along the exposed contact of the crystalline rocks of the Grenville series and the overlying Potsdam sandstone or Little Falls dolomite; other springs are found along exposures of the Little Falls dolomite and to a lesser extent where valleys have been cut into the black shales of the Ordovician. Table 6 shows the records of selected springs in Montgomery County.

UTILIZATION OF WATER

With respect to use, wells and developed springs in Montgomery County may be classified as (1) primary and auxiliary public-water supplies, (2) industrial and commercial supplies, and (3) domestic, stock, and semipublic supplies in rural areas and in villages that are not served by public systems.

Public Supplies

About two-thirds of the residents in the county are dependent upon public supplies obtained from surface waters, but the remaining one-third rely directly upon ground water. Eight municipalities in Montgomery County are served by public water-supply systems, three

Table 6.—Records of selected springs in Montgomery County, New York.

Spring number	Location[a]	Owner	Altitude above sea level (feet)[b]	Topography	Geologic subdivision[c]	Yield (gallons per minute)	Temperature (°F.)	Use[d]	Remarks
Mt 1Sp	8U, 15.0S, 1.6E	John W. Davis	680	Upland	Glens Falls and Amsterdam lss.	10	49	Farm	Equipped with two suction pumps.
Mt 2Sp	8U, 16.6S, 1.2E	Cecil Hildabrandt	400	Valley	Little Falls dolomite	4	..	Farm	Concrete collecting basin.
Mt 3Sp	8U, 15.3S, 2.3E	Frank B. Smith	750	Upland	Glens Falls and Amsterdam lss.	..	..	Farm	Improved with tile 4 feet in diameter and 6 feet deep.
Mt 4Sp	8U, 15.5S, 2.7E	S. Bellinger	750	Upland	Little Falls dolomite	3	..	Farm	Improved with tile. Gravity flow to buildings.
Mt 5Sp	8U, 16.1S, 3.1E	L. Lamphere	710	Hillside	Little Falls dolomite	6	..	Dom	Equipped with suction pump.
Mt 6Sp	9U, 1.8S, 8.0E	Benjamin Hisert	420	Valley	Recent alluvium	..	..	Farm	Springs at this location. Gravity flow to buildings.
Mt 7Sp	9U, 2.8s, 7.2E	Ida M. Barret	460	Hillside	Canajoharie shale	50	50	Farm	Concrete collecting basin. Equipped with suction pump.
Mt 8Sp	9U, 3.3S, 9.1E	Oliver Philips	800	Upland	Canajoharie shale	..	..	Farm	Concrete collecting basin. Gravity flow to buildings.
Mt 9Sp	9V, 4.2S, .8E	J. Klutz	910	Upland	Little Falls dolomite	..	..	Farm	Gravity flow to buildings.
Mt 10Sp	9V, 1.9S, 2.7E	......	560	Upland	Potsdam sandstone	3	..	Farm	Gravity flow to buildings.
Mt 11Sp	9V, 1.8S, 2.8E	......	560	Upland	Potsdam sandstone	3	..	Farm	Gravity flow to buildings.
Mt 12Sp	9V, 4.2S, 4.7E	Floyd Nare	300	Valley	Pleistocene gravel	4	..	Farm	Improved with tile. Gravity flow to buildings.
Mt 13Sp	9W, 5.5S, 7.6E	County sanatorium	590	Hillside	Little Falls dolomite	36	..	Dom	Supplies about 35 patients. Large fluctuation in yield is reported. Pumped into reservoir of 20,000 gallon capacity.
Mt 14Sp	9U, .9S, 4.1E	James H. Sanders	460	Hillside	Pleistocene gravel	..	..	Farm	Gravity flow to buildings.
Mt 15Sp	9U, 1.5S, 4.7E	R. B. Crouse	400	Hillside	Pleistocene gravel	..	..	Farm	Gravity flow to buildings.
Mt 16Sp	9U, 2.8S, 1.7E	Harland Oldich	670	Upland	Pleistocene till	3	..	Farm	Equipped with suction pump.
Mt 17Sp	9U, 4.6S, 2.5E	R. Smith	570	Valley	Canajoharie shale	3	..	Farm	Gravity flow to buildings.
Mt 18Sp	9U, 6.8S, 9.1E	Village of Canajoharie	440	Hillside	Glens Falls limestone	100	..	PWS	Equipped with centrifugal pump. Water is pumped directly into distribution system.[e]
Mt 19Sp	9W, 8.6S, 3.2E	William Staley	840	Upland	Canajoharie shale	..	..	Farm	Concrete collecting basin. Gravity flow to buildings.

a. For explanation of location symbols see section entitled, "Methods of investigation."
b. Approximate altitude from topographic map.
c. Lss., limestones.
d. Dom, domestic; PWS, public water supply.
e. For chemical analysis see table 8.

obtain water from ground-water sources and five from surface streams. All these systems are municipally operated.

Fort Plain and Nelliston.—Fort Plain and Nelliston, in the north-central part of the county, obtain water from North Creek at a point about 8 miles north of Nelliston. The entire system is gravity-controlled, the water flowing from the intake to a 25-million-gallon storage reservoir about 1 mile north of Nelliston, and then into the distribution mains. The average consumption is about 900,000 gallons a day. The water is of good quality and is treated regularly with chlorine, and with copper sulfate when necessary to remove tastes due to algae. Chemical analyses of the water are given in table 8. The supply is ample during most seasons, although becoming slightly low in protracted droughts.

Palatine Bridge.—Palatine Bridge, opposite Canajoharie on the north bank of the Mohawk River in western Montgomery County, obtains its water supply from a drilled well (Mt 47) about two miles northeast of the village. This well was drilled to a depth of 800 feet in an unsuccessful search for oil and gas, and was subsequently plugged back to 625 feet and utilized by the village. The water is lifted from the well by a 15-horsepower electric turbine pump and forced through a base-exchange softening system into a 300,000-gallon reservoir. The consumption averages about 50,000 gallons a day. The water after softening is of good quality for industrial and domestic use. Data on the supply well is given in the section on well records and a chemical analysis of the untreated water is given in table 8.

Amsterdam.—Amsterdam, the county seat and largest city in the county, obtains its water supply from three artificially impounded surface reservoirs in the vicinity of Hans Creek northeast of the city in Fulton County. The water moves by gravity to a 10-million-gallon reservoir above the city and by gravity throughout the distribution system. An average of 10 million gallons of water is used daily, about 50 percent being used by industry and the New York Central Railroad. Treatment includes the addition of chlorine and ammonia regularly, and copper sulfate when needed. Chemical analyses of the water are given in table 8.

St. Johnsville.—St. Johnsville, in the northwestern part of the county, is served by two water systems, one for domestic supply and another for industrial supply. The domestic supply is obtained from spring-fed creeks in Fulton County about 8 miles north of the village. The flow is entirely by gravity and the pressure in the village ranges from 75 to 100 pounds per square inch. About 300,000 gallons of water are used each day. Treatment consists of the addition of chlorine and ammonia.

The industrial supply is obtained from Zimmerman Creek just northeast of the village and the supply flows by gravity through a separate distribution system to the several industrial consumers.

Fultonville.—The village of Fultonville, on the south bank of the Mohawk River opposite Fonda, obtains its water supply from two drilled wells (Mt 264 and Mt 265) just south of town. The water is pumped from the wells to the 300,000-gallon storage reservoir, and flows by gravity through the distribution system. The daily consumption is about 30,000 gallons. One of the wells yields water of satisfactory quality, but the other well produces water that is high in chloride, hardness, dissolved solids, and hydrogen sulfide. Chemical analyses of the water are given in table 8.

Fonda.—The municipality of Fonda, which lies on the north bank of the Mohawk River in the central part of the county, obtains its water supply from Briggs Run about 4 miles west of the village. The system is under gravity flow and the consumption averages about 350,000 gallons a day. Chlorination is the only treatment used. A chemical analysis of the water is given in table 8.

Canajoharie.—The water supply of Canajoharie, which is 23 miles west of Amsterdam, is obtained from the headwaters of Sprite Creek, Fulton County, and from springs near Canajoharie. Practically all the system is under gravity flow. It includes a 1.7-million-gallon storage reservoir. The consumption is approximately 750,000 gallons a day. Chemical analyses of the water are given in table 8.

Industrial and Commercial Supplies

Industries require large supplies of water, and the location of new industries often is determined chiefly by the availability of a large supply of ground water of suitable quality. Many industrial establishments are located outside the areas served by public water-supply systems, and must, therefore, develop their own sources of water for a variety of purposes. Some other plants within towns and cities find that privately operated water systems are more economical when large volumes of water are required. For many industries it is almost a necessity to develop ground water because of its inherent advantages over surface water for certain uses. These advantages include its nearly uniform year-round temperature, which in the summer is lower than that of surface water, and its uniform and simple chemical composition. Treatment other than chlorination of some drinking water generally is not necessary. In both urban and rural areas in Montgomery County laundries, dairies, theaters, railroad shops, and beverage, milk-processing, and food-packing plants use water from wells in their product or for cooling and condensing purposes. At least one well is used for disposal of excess water that collects in sumps.

Domestic and Stock Supplies

Most of the inhabitants of farms and small communities not served by public systems, and the rural schools, rely upon wells and springs for water supply, although a few depend wholly or partly upon rain water collected in cisterns. Streams are generally avoided because of the danger from contamination. A substantial proportion of the wells, however, yield water that is not protected adequately against pollution.

About 85 percent of the homes in the county had running water in 1940 (Department of Commerce, p. 26), but these data include urban as well as rural homes. Most of the rural water supplies are obtained by means of dug wells, although shallow drilled wells are increasing in number. Recurrent droughts periodically create serious problems in the diminution or complete failure of water supplies from shallow wells, springs, and cisterns in the rural areas.

Small to moderate supplies of ground water adequate for most domestic and stock use are developed from shallow wells drilled into the consolidated rock formations or from dug, drilled, or driven wells in the sand and gravel deposits. Locally, springs may constitute an adequate source. These installations should be tested carefully to determine the adequacy for the required withdrawals (table 7) and to determine the sanitary quality.

Miscellaneous uses of ground water include the semi-public supplies in resorts, roadside watering places, special drinking-water systems in industrial or commercial establishments, and bottled water for medicinal or table purposes. For such uses the important characters of water are its potability, sanitary purity, freedom from injurious elements, and the presence or absence of dissolved minerals of real or supposed medicinal value.

"Mineral" ground water in Montgomery County is not used now for medicinal purposes except by persons living near the sources. Some of the waters containing hydrogen sulfide, however, are comparable to the "sulfur waters" that are used extensively at Sharon Springs in Schoharie County just south of the Montgomery County line.

Table 7.—Daily water requirements on the farm. Adapted from Graver (1946, p. 12)

	Gallons		Gallons
Each member of family, including all purposes as cooking, laundering, bath, and toilet	50	Each beef cow	12
Each work horse	12	Each hog	4
Each milk cow	20[a]	Each sheep	2
		100 chickens	4
		100 turkeys	7

[a]Add 15 to 20 additional gallons a day for each cow, for flushing stable and for washing dairy utensils.

Possibility of Future Development

The feasibility of developing additional supplies of water from the subterranean reservoirs in Montgomery County is dependent upon the safe yield of the water-bearing formations, or the amount of water that can be withdrawn over a long period of years without critical depletion, and upon economic factors such as drilling, pumping, and exploration costs. At the present time withdrawals of ground water in the county do not exceed a small fraction of that available, but locally in the urban areas of Canajoharie and Amsterdam the use of ground water probably is approaching the safe yield. Water levels and yields of wells in these areas should be watched carefully to determine conditions more exactly and to give warning of approaching water-supply difficulties. Over essentially all of Montgomery County, additional supplies of water adequate for stock and domestic supply are available from wells drilled into the Little Falls dolomite or the Canajoharie and Utica shales, and screened, drilled or driven wells in the permeable unconsolidated material along the Mohawk River will yield somewhat larger quantities of water of better quality.

Seemingly, some extensive areas of permeable unconsolidated water-bearing material, such as at Tribes Hill, west of Fonda, at Auriesville, and southwest of St. Johnsville, could be developed to yield moderate to large supplies of water for public or industrial use. Comparatively small areas of coarse gravel that constitute the best water-bearing material in Montgomery County occur between Randall and Stone Ridge, across the Mohawk River at Yosts, and just east of Fort Hunter. Properly constructed wells in these areas should yield large supplies of water. Upland areas away from the Mohawk River are unfavorable for development of moderate to large supplies of ground water, although small stock and domestic supplies can be obtained generally.

QUALITY OF WATER

Information on the chemical characteristics of water supplies is necessary before plans are made for the location of industries and for economical and satisfactory treatment of water for domestic and industrial consumption. When the inherent properties of the water are known accurately, the most suitable equipment for water treatment, steam-boiler plants, or air-conditioning use can be planned and unnecessary equipment or treatment can be eliminated.

Chemical analyses of water collected from different sources throughout the county by H. R. Rockefeller were analyzed by the Department of Sanitation of the New York State Health Department. Analysis of water from three wells were furnished by the Beech Nut Packing Co., Canajoharie, and analyses of several public supplies were furnished by the Health Department. These data, which are given in table 8, indicate generally the character of all public supplies and representative ground-water supplies throughout Montgomery County.

The minerals and gases present in ground water are those absorbed or taken into solution by the water as it fell through the air as rain and as it moved through the soil and rock. The variations in the quantity of mineral matter in different waters depends, among other things, upon the chemical composition of the rock materials and the duration of the contact with them, the temperature, the pressure, and reactions between the soil and rock and the constituents in the water previously dissolved from other rock.

In general the character and amount of the mineral and gases in water from a given ground-water source remain relatively constant throughout the year. although changes may occur very gradually during longer periods. Water from shallow wells or channels in limestone, however, may fluctuate in composition in accordance with variations in the rate of recharge and discharge. Also, where wells draw water from alluvial aquifers that are recharged to a greater or lesser degree by infiltration from a nearby stream, the chemical composition of the well water may change decidedly with changes in the rate of inflow or in the composition of the river water.

The analyses of water from wells in Montgomery County are shown graphically on figures 7 and 8 to illustrate the considerable variation in the character of the ground waters.

Table 8.—Chemical analyses of water from wells, springs, and municipal supplies in Montgomery County, New York.

(Analyses by New York State Department of Health unless indicated otherwise. Dissolved constituents given in parts per million.)

Well or spring number	Depth (feet)	Geologic subdivision	Date of collection	Dissolved solids	Iron (Fe)	Manganese (Mn)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Hardness (as $CaCO_3$) Total	Hardness (as $CaCO_3$) Carbonate	Hardness (as $CaCO_3$) Noncarbonate	Total alkalinity as $CaCO_3$	pH
Mt 19	100	Little Falls dolomite	10-17-46	385	0.25	0.02	348	47	10	..	300	285	15	285	7.7
Mt 47	625	Little Falls dolomite	10-17-46	376	.01	.01	317	59	7.4	..	370	260	110	260	7.5
Mt 65	69	Potsdam sandstone	8-28-46	366	1.2	.02	334	61	.6	..	370	274	96	274	7.5
Mt 78	42	Amsterdam and Glens Falls lss.[a]	9-6-46	317	.8	.02	350	21	37	..	300	287	13	287	7.4
Mt 93	18	Pleistocene gravel	8-29-46	175	.35	.01	96	26	12	..	140	79	61	79	7.2
Mt 116	217	Little Falls dolomite	8-1-46	388	1.7	.05	324	62	4.6	..	340	265	75	265	7.4
Mt 124	82	Little Falls dolomite	10-16-46	299	1.2	.01	260	52	3.0	..	260	213	47	213	7.7
Mt 135	74	Little Falls dolomite	11-12-46	250	.15	.01	243	27	2.2	..	220	199	21	199	7.7
Mt 161	60	Canajoharie and Utica shales	10-17-46	543	1.8	.08	330	90	26	..	370	270	100	270	7.3
Mt 185	37	Pleistocene gravel	6-14-46	515	.6	.15	354	83	49	..	360	290	70	290	7.2
Mt 203	99	Pleistocene till	9-5-46	375	.8	.02	314	63	20	..	290	257	33	257	7.6
Mt 209[b]	625	Little Falls dolomite	10-1-44	336	..	..	264	120	22	..	192	192	0	216	7.6
Mt 210[b]	80	Pleistocene gravel	10-1-44	..	..	..	258	140	18	..	192	192	0	212	7.4
Mt 229	185	Canajoharie and Utica shales	6-28-46	446	.6	.01	432	33	7.8	..	220	220	0	354	7.9
Mt 234	96	Schenectady formation	10-17-46	406	.05	.01	350	43	20	..	350	287	63	287	7.3
Mt 251	315	Little Falls dolomite	6-20-46	8,660	1.0	.01	177	0	3,750	..	1,200	145	1,055	145	7.9
Mt 254[c d]	96	Canajoharie shale	9-9-47	556	.29	.0	497	60	24	5.6	408	408	0	408	7.05
Mt 255	98	Canajoharie and Utica shales	7-10-46	779	1.0	.08	421	18	10	..	60	60	0	345	6.8
Mt 257	282	Canajoharie and Utica shales	9-6-46	978	6.9	.1	640	91	62	..	190	190	0	525	7.5
Mt 264	360	Little Falls dolomite	....	..	.07	..	27	..	2.2	.02	20	20	0	22	7.3
Mt 265	280	Little Falls dolomite	10-17-46	837	.25	.08	272	5.6	210	..	410	223	187	223	7.7
Mt 284	73	Schenectady formation	9-5-46	384	.15	.03	333	80	1.8	..	220	220	0	273	7.6
Mt 301	95	Canajoharie and Utica shales	7-8-46	589	1.0	.25	496	16	160	..	136	136	0	406	7.1
Mt 308	99	Pleistocene gravel	10-17-46	1,230	1.3	.05	187	7.2	460	..	400	153	247	153	7.9
Mt 315	96	Canajoharie and Utica shales	9-6-46	558	.05	.01	426	112	28	..	460	350	110	350	7.2
Mt 319	100	Canajoharie and Utica shales	8-17-46	859	2.0	.01	580	46	175	..	50	50	0	475	8.4
Mt 352	129	Canajoharie and Utica shales	10-16-46	424	.15	.01	392	35	6.8	..	260	260	0	321	7.5
Mt 358	59	Little Falls dolomite	9-6-46	282	.8	.01	287	29	6.2	..	220	220	0	235	7.9
Mt 18Sp	..	Glens Falls limestone	10-18-46	437	.01	.01	290	88	26	..	280	238	42	238	7.5
Municipal Supplies, surface water															
		Amsterdam, Hans Creek reservoir	11-4-42	..	.7	..	9	..	2.2	.04	28	7	21	7	5.5
		Amsterdam, Hans Creek reservoir	8-22-44	..	1.2	.03	2	..	.6	.02	14	1	13	1	7.0
		Canajoharie, Sprite Creek	10-18-46	195	.05	.01	140	8.2	.4	..	128	115	13	115	7.9
		Fonda, Briggs Run	10-17-46	437	.01	.01	291	88	26	..	280	238	42	238	7.5
		Fort Plain and Nelliston, North Creek	10-13-42	..	.13	..	116	..	1.8	.04	100	95	5	95	7.7
		Fort Plain and Nelliston, North Creek	7-24-44	..	.1	..	122	..	1.4	.04	100	100	0	100	8.1
		St. Johnsville, Zimmerman Creek	10-17-46	134	.01	.01	117	5.7	.6	..	96	96	0	96	7.8

a. Lss., limestones.
b. Analysis obtained from Beech-nut Packing Company, Canajoharie, New York.
c. Analysis by Quality of Water Branch, U. S. Geological Survey.
d. Silica, 11 p.p.m.; calcium, 119 p.p.m.; magnesium, 27 p.p.m.; sodium and potassium as Na, 47 p.p.m.; floride, 0.5 p.p.m.

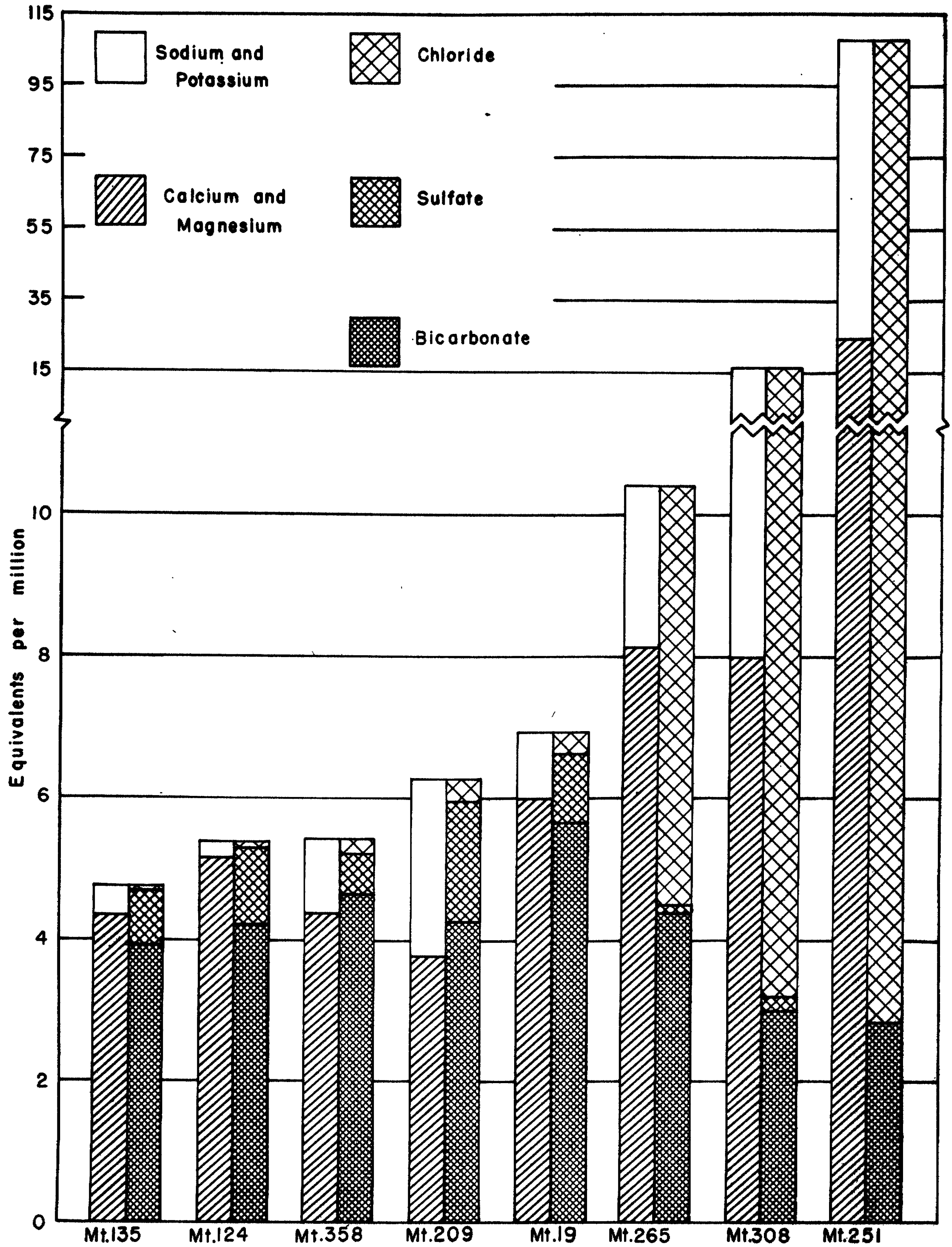

Figure 7.—Analyses of waters from the Little Falls dolomite in Montgomery County. Concentration of calcium plus magnesium computed from total hardness.

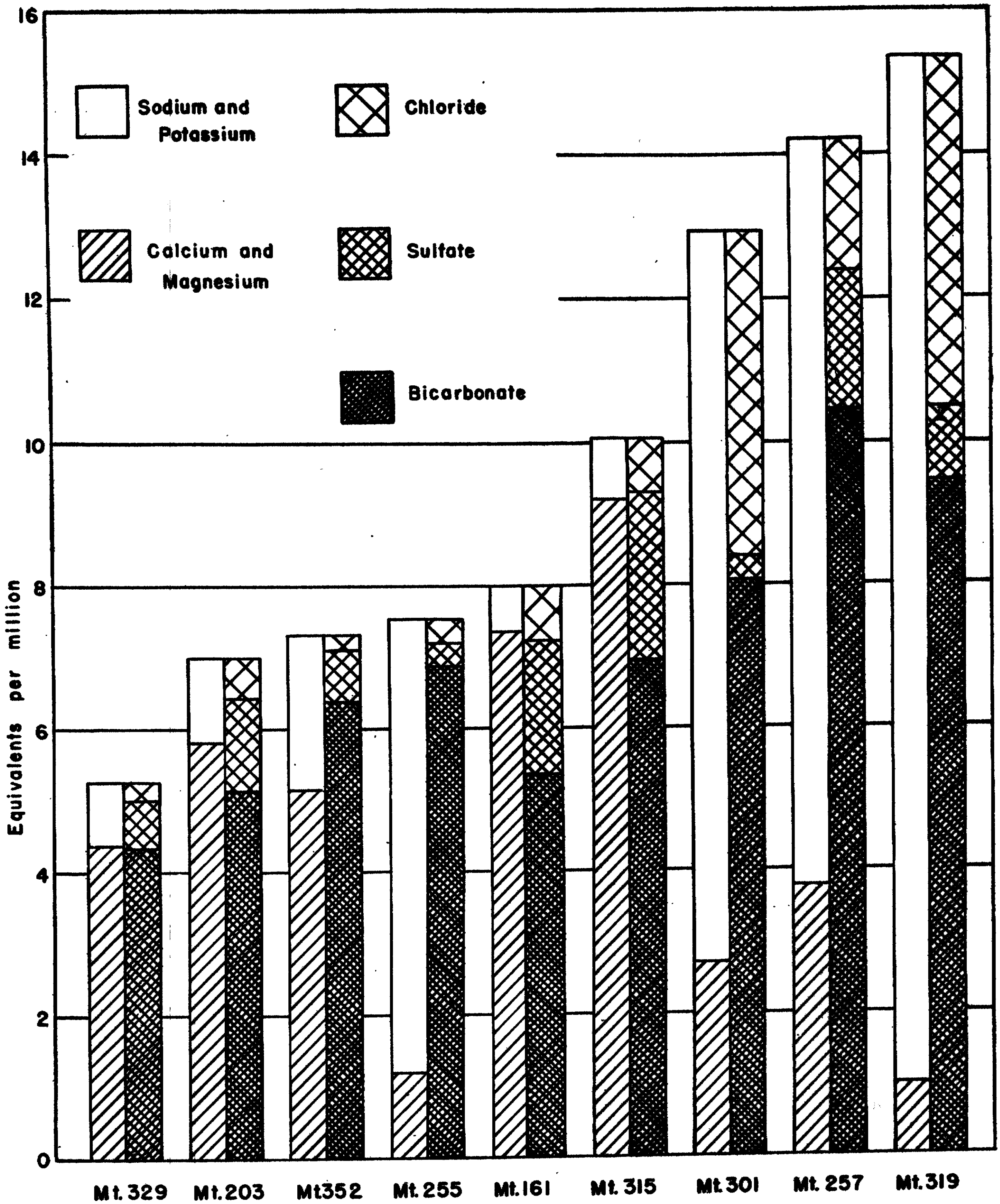

Figure 8.—Analyses of waters from the Canajoharie and Utica shales in Montgomery County. Concentration of calcium plus magnesium computed from total hardness.

Chemical Constituents in Relation to Use

Much of this discussion has been adapted from publications of the U. S. Geological Survey.

The chemical properties of water that determine its acceptability for domestic, stock, and industrial uses include principally the dissolved solids, the total hardness, the iron content, and the amount of hydrogen sulfide (rotten-egg gas). Certain other constituents, such as sodium chloride (common salt) and manganese, occur in sufficient abundance locally to affect the use of the water.

Dissolved solids.—The residue remaining after evaporation of a natural water consists of the mineral constituents dissolved in the water and generally a little organic matter and water of crystallization. Waters having less than 500 parts per million of dissolved solids generally are satisfactory for domestic, stock, and many industrial uses, except for difficulties resulting from hardness or occasional excessive iron content. Waters having more than 1,000 parts per million of dissolved minerals are likely to contain enough of certain constituents to produce an objectionable taste or to make the water unsuitable in some other respects. Some waters in this latter category may be used successfully for certain industrial purposes, such as cooling.

The known concentrations of dissolved solids in ground waters in the county range from 175 parts per million for a shallow well near Tribes Hill to 8,660 parts per million for a deep well at Randall (fig. 9). Most of the samples contained less than 500 parts per million.

Hardness.—This is the characteristic of water that generally receives the most attention in domestic and industrial use of water. It is recognized by the increased quantity of soap that is required to produce a lather, and by the deposit of insoluble mineral scale in boilers or kettles when a hard water is heated or evaporated. Carbonate hardness, or that due to the calcium and magnesium equivalent to the bicarbonate in the water, may be removed almost completely by boiling; but noncarbonate hardness, caused by other compounds of calcium and magnesium, such as chlorides or sulfates, cannot be removed by boiling. Both carbonate and noncarbonate hardness affect the use of soap. The noncarbonate hardness is particularly troublesome in steam boilers, producing a harder scale.

Water having a hardness of less than 60 parts per million is considered soft, and it is not profitable to soften such waters artificially except for certain industries that use water having nearly 60 parts in steam boilers. A hardness from 60 to 120 parts per million does not seriously affect domestic and most industrial use of water, although the consumption of soap is increased somewhat. Municipal softening is not usually practiced but household softening equipment is sometimes installed. Softening of the water is likely to be profitable for a laundry, and prior softening or treatment within the boiler is generally necessary for a steam-boiler plant. The effect of water having a hardness of 121 to 200 parts per million is noticed by nearly everyone and such water must be softened for use in any industrial process for which hard water is detrimental. Household softeners are desirable, and softening of municipal supplies may be profitable. Waters having a hardness greater than 200 parts per million are considered to be very hard and are objectionable for many domestic and nearly all industrial uses. Softening of municipal supplies is costly but generally profitable, particularly where the hardness is more than 300 parts per million. The cost may be reduced by mixing the very hard water with softer water from other wells or a stream.

The hardness of water from wells and springs in Montgomery County ranges from 20 parts per million in one of the public-supply wells at Fultonville to 1,200 parts per million in a deep well at Randall (table 8, fig. 9). Most ground waters, however, have a hardness of less than 400 parts per million. The public supply for Palatine Bridge is softened for general domestic use, but most private domestic supplies are not treated. Inasmuch as these domestic supplies are mostly rather hard, rain water is collected in cisterns for use when soft water is desired.

Hard water is objectionable in some processes in the soap, tanning, bleaching, high-grade-paper, dyeing, textile, and canning industries. Also, commercial laundries require water that has practically zero hardness for economical and satisfactory operation. Most of the waters in Montgomery County may be softened satisfactorily, although not economically in some cases, by use of zeolite (exchange silicate) softening processes or by the addition of lime or lime and soda ash.

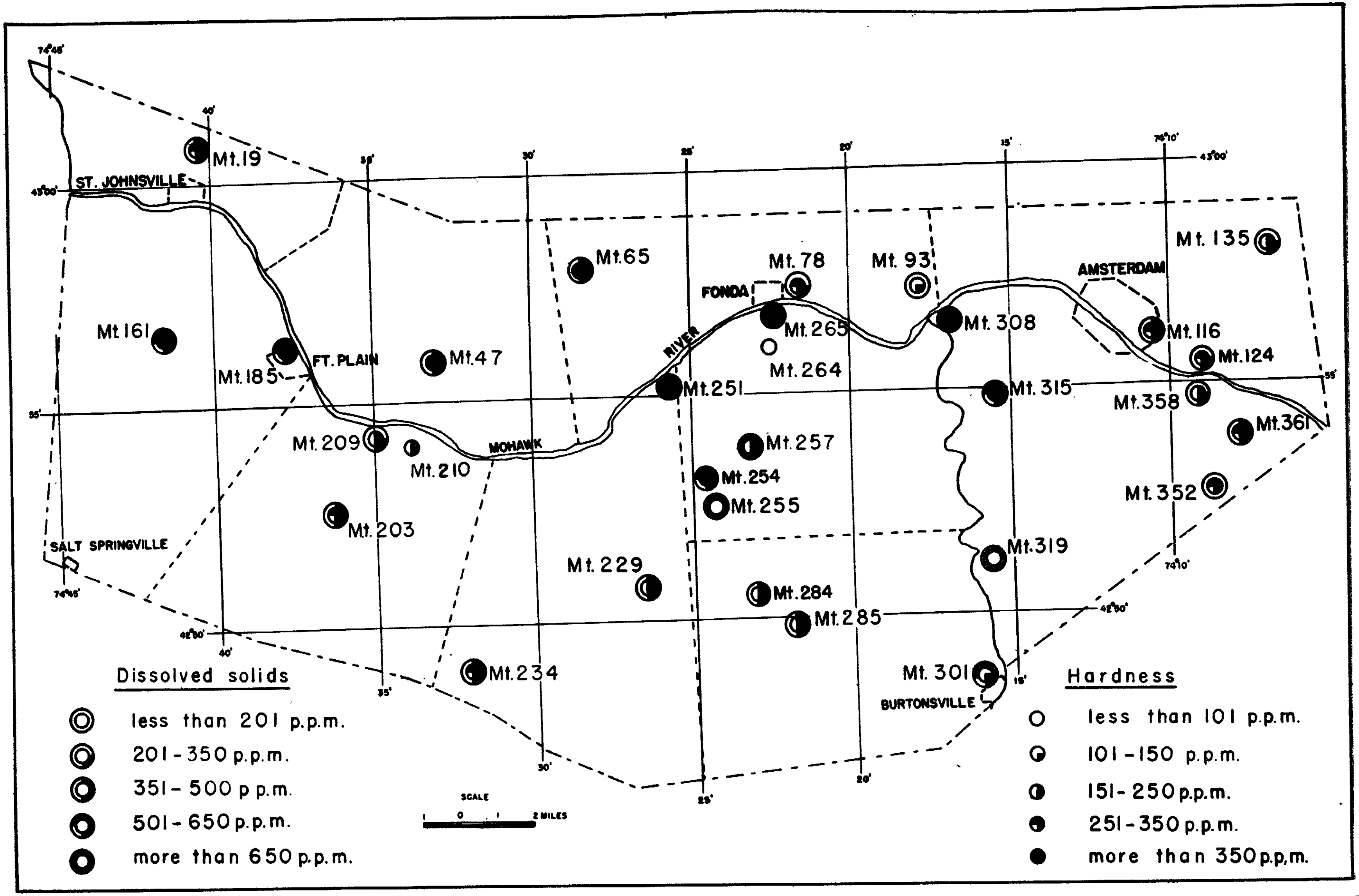

Figure 9.—Map of Montgomery County showing areal distribution of dissolved solids and hardness in well waters.

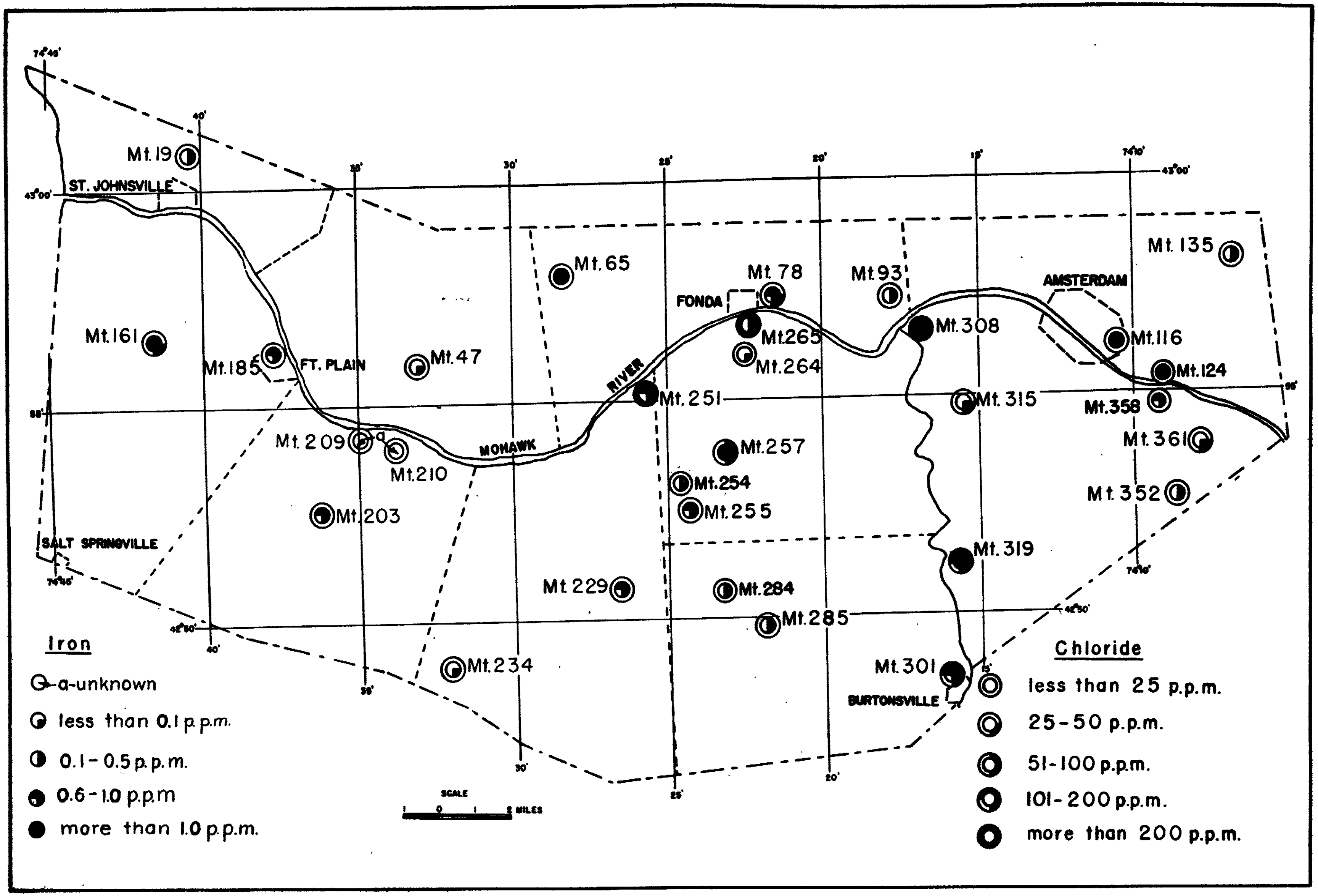

Figure 10.—Map of Montgomery County showing areal distribution of iron and chloride in well waters.

The very soft waters occur in the deeper wells and are believed to have been naturally softened by substitution of sodium for the calcium and magnesium through reaction with natural base-exchange silicates (clay minerals) in the rocks through which these waters move.

Iron.—Many of the wells yield water relatively high in iron, (fig. 10) usually in the form of iron bicarbonate. As the water is exposed to air, carbon dioxide is released and oxidation of the iron occurs causing the iron in excess of about 0.2 part per million to separate as a reddish flocculent sediment. Some corrosive waters that lack iron as they occur in the rocks may dissolve sufficient iron from the casing or pump pipe to appear at the surface with high iron content.

Water that has a high iron content is disagreeable in taste and appearance and causes reddish-brown stains on porcelain or enamel ware and on fabrics that are washed in it. Moreover, such waters discolor food when used in cooking, especially tea and coffee. Many industrial plants, including those manufacturing and preparing foods, carbonated beverages, pottery, textiles, chemicals, high-grade paper, and ice, require a water practically free from iron. Excessive amounts of iron generally can be removed by aeration followed by settling or filtration, although a few waters may require the addition of lime or other chemicals. Some conventional water-softening devices also remove iron from the water. The occurrence of iron in ground water is rather erratic and nearby wells may differ markedly in iron content. A concentration of iron in excess of 0.2 part per million occurs in about 70 percent of the ground waters that were analyzed; the iron content ranges from less than 0.01 part per million in several wells to 6.9 parts per million in a well 7 miles south of Fultonville.

Hydrogen sulfide.—This gas gives the characteristic "rotten-egg" odor found in waters in many wells. Waters containing as much as 1 part per million of this gas are disagreeable to taste and smell, and also may be quite corrosive. Aeration or exposure of the water to air commonly permits escape of the noxious gas. Many waters seem to contain hydrogen sulfide as they occur in the reservoir rock. This gas may develop secondarily, however, by the action of anerobic bacteria in water within a well or in pipes after the water has left the aquifer. These sulfate-reducing bacteria may be killed or reduced to a dormant state by treatment of water with a disinfectant such as chlorine. The hydrogen sulfide in waters in Montgomery County probably arises from chemical and bacterial action which reduces the iron sulfates within the black shales to sulfides.

The odor of hydrogen sulfide was noted in the field in waters from many wells, but the gas is not detected after the samples were received in the laboratory.

Miscellaneous constituents.—The deep-lying strata may contain water that is strongly saline. The salt and other mineral substances in these brines doubtless were trapped in the sediments as they were deposited beneath the sea, but during succeeding ages the brine was modified to some extent by the addition of fresh water, solution of additional rock materials, loss of part of the water, and other factors. Only six of the samples showed objectionable amounts of chloride, but excessively deep wells throughout most of the county probably would encounter water high in chloride.

Fluoride in water has been shown to be associated with the dental effect known as mottled enamel, which may appear on teeth of children who regularly drink water containing more than 1 part per million of fluoride (Dean, 1936). The incidence is negligible at contents less than 1.5 parts per million, the limit now recommended by the Public Health Service for water used on interstate carriers. Additional investigations have indicated, moreover, that waters containing small amounts of fluoride (less than 1 part per million) may be an important factor in decreasing the incidence of dental caries (tooth decay) (Dean, Jay, Arnold, and Elvove, 1941). Three samples of ground water from Montgomery County analyzed for fluoride were found to contain only small amounts. The State Health Department found 0.62 part per million of fluoride in the deeper public-supply well at Fultonville, and 0.03 part per million in the public-supply well at Palatine Bridge. Water from well Mt 118 near Amsterdam contained 0.5 part per million.

Sanitary Considerations

The analyses given in table 8 show only dissolved mineral content and certain chemical properties of the waters; they do not in general indicate the sanitary condition. Abnormal quantities of some mineral compounds, such as nitrate, however, may suggest pol-

lution of the water. A water may contain sufficient quantities of dissolved minerals or gases to cause disagreeable tastes or odors and yet be lacking in injurious bacteria. Other waters may be teeming with harmful bacteria and organic pollution, and yet be clear and pleasing to the palate. Contaminated water may contain the microscopic organisms that cause typhoid fever, dysentery, diarrhea, or intestinal worms in man, as well as cause tuberculosis, hog cholera, anthrax, glanders, and stomach and intestinal disorders (Garver, 1946, p. 3).

Public supplies in Montgomery County are checked regularly and are treated carefully to prevent polluted water from reaching the homes. Much of the rural population, however, is dependent upon private wells so that well owners and drillers should exercise great care to safeguard these supplies from hidden organic pollution. Wells should be constructed so as to seal off drainage at and near the surface. They should not be located in the vicinity of possible sources of pollution such as privies and barnyards. In areas where the surface is underlain by limestone, such pollution may move very readily through joints and solution openings, and special precautions should be taken. The practice of draining sewage and wastes into disposal wells or undrained depressions in these limestone areas is particularly deleterious, inasmuch as the polluted water may travel directly to wells a considerable distance away.

Drilled wells generally are protected by casing if adequately sealed at the top, but many dug wells are poorly sealed near the surface so that they are subject to contamination. Improperly sealed wells may show evidence of pollution only at irregular intervals, thereby giving a false assurance of safety.

Quality in Relation to Stratigraphy

The analyses listed in table 8 indicate that certain mineral constituents may be characteristic of waters derived from particular geologic formations, but also that the character of waters in the same formation may change from place to place, especially with increasing depth (figs. 7 and 8). These data facilitate prediction of the chemical type of water that may be obtained in a given area at a given depth. Also, useless drilling may be prevented in areas where suitable water does not occur, or permit an advance estimate of the cost of treatment of such water as may be available.

Water from the Little Falls dolomite ranges greatly in the quantity of dissolved solids and in other constituents, but commonly the concentration of sodium and chloride increases with depth (fig. 7). Waters from the Canajoharie and Utica shales (fig. 8) generally contain an appreciably larger proportion of sodium, and the concentration of chloride does not increase as rapidly at depth. The glacial till and outwash deposits yield water that is low in dissolved solids and in other constituents except where water from the consolidated rock formations is moving into these surficial deposits.

Temperature

Information on temperature of ground waters is useful to industries in which the efficiency of the system is dependent to some extent upon the temperature of the water used. The increasing use of ground water for air conditioning by theaters, stores, office buildings, and a few private homes has increased greatly the need for adequate data on the temperature of water from wells. The variations in temperature of the available supplies of water are also of primary value to the several milk-processing plants in the county that use ground water for cooling purposes.

The great advantage of ground water for cooling purposes is its uniform temperature, which during the summer is lower than that of surface water. The temperature of water from wells of moderate depth was observed to range from 42° to 56°F. and averaged about 50°F. Very deep wells may yield somewhat warmer water. Except in the alluvial aquifers that are recharged by water from a nearby stream, the temperature of water in any particular well more than about 30 feet deep probably does not vary more than 2° or 3° F. during the year. Water in shallow dug wells, however, ranges more widely in temperature and that in streams still more widely.

WATER-BEARING FORMATIONS

PRE-CAMBRIAN ROCKS

Grenville Series

As exposed in Montgomery County the Grenville series comprise sandstones, shales, and igneous rocks that have been extensively metamorphosed to crystalline foliated schists and gneisses (pl. 2). The original characteristics of the sedimentary rocks have been entirely obliterated. From a study of thin sections, Kemp and Hill (1901, pp. r32-r35) found that the Grenville in the vicinity of the Noses is largely a garnetiferous schist. Quartz is the most abundant mineral, and the rock contains also reddish-brown biotite, light-red garnet, and minor amounts of plagioclase feldspar. The contorted schist is intimately associated with masses of hornblendic gneiss.

The Grenville series in Montgomery County is exposed only in a small area on both sides of the Mohawk River at the Noses just west of Yosts and in an intermittent belt northward to the county line. These rocks, however, underlie all other rocks in Montgomery County and may be encountered in deep wells. The position of the base of the Grenville series is not known, but these rocks are considered to be approximately 10,000 feet thick in the Broadalbin area, in Fulton and Saratoga Counties (Miller, 1911).

The crystalline rocks in Montgomery County are undoubtedly comparable in age to similar rocks that are exposed throughout much of the Adirondacks and in the border areas. The relation of the Grenville to pre-Cambrian rocks of the Lake Superior region is uncertain. They are placed in the early part of the pre-Cambrian by some writers and much later by others (Quirke and Collins, 1930).

The limited occurrence of pre-Cambrian rocks at the surface and their occurrence elsewhere beneath better water-bearing formations precludes extensive water-supply developments. Shallow to moderately deep wells that encounter fractures and crevices in the zone of weathered rock, however, may yield small supplies of good water for domestic and farm use. Inasmuch as the yield of wells is dependent upon the number and size of the joints and other openings that are encountered, drilling should be limited to the upper 100 to 200 feet where these openings are more abundant. Water from the Grenville series commonly is quite soft and low in iron.

Locally, water percolating downward through the overlying formations moves laterally over the surface of the Grenville to emerge as springs and seeps along the edge of the outcrop of crystalline rocks.

PALEOZOIC ROCKS

Cambrian System

Potsdam sandstone.—The oldest Paleozoic formation is the Potsdam sandstone, a relatively pure, thick-bedded vitreous sandstone made up of medium-sized quartz grains cemented by silica. The sandstone is light gray to buff in color and weathers white to gray. Many of the individual grains are well rounded and frosted so as to indicate rounding and abrasion by wind action. Inasmuch as these characters may persist on sand grains after they leave the eolian environment, it is not certain that much if any of the formation was deposited by the wind in Montgomery County.

The Potsdam sandstone was named for exposures in St. Lawrence County (Emmons, 1838), and the formation occurs extensively on the north, south, and east edges of the Adirondacks. South and west from Saratoga County the sandstone thins rapidly and dissappears entirely between Yosts and Little Falls. Exposures west of the Noses fault (pl. 2) did not permit determination of the thickness, but probably these sandy beds are less than 50 feet thick. The Potsdam sandstone was not observed in the bluff near the southwestern corner of Mohawk Township, but float blocks of sandstone indicate that it is present. At the railroad cut on the south side of the river, dolomitic layers similar to the Little Falls dolomite occur within a few feet of the top of the crystalline rocks. A hard vitreous sandstone layer comprises the lowest bed along the bluff a few hundred feet to the west, and this may represent

the Potsdam sandstone. Evidently, the massive beds of sandstone are lacking in the western part of the county, but basal layers of the Little Falls dolomite may contain considerable sand.

The Potsdam sandstone comprises beds containing locally a few fossiliferous zones that indicate Upper Cambrian age. Although such fossils were not observed in Montgomery County, the distinctive lithology permits reliable correlation with more extensive exposures around the Adirondacks. The Potsdam sandstone in the Saratoga region gradually gives way upward to alternating layers of gray sandstone and dolomite, the Theresa dolomite. In places, as at Saratoga, also, the upper part of the Theresa consists of alternating beds of dolomite and fossiliferous limestone, the Hoyt limestone member. Theresa was not recognized in Montgomery County, where the interval between the Grenville series and the Little Falls dolomite is relatively thin and not well exposed.

Although the Potsdam sandstone contains relatively impervious vitreous quartzite layers, some beds seem quite permeable. Springs and seeps are especially abundant along the contact of the sandstone and the underlying crystalline rocks of the Grenville series. A few shallow wells also obtain small to moderate supplies of water from the Potsdam sandstone along the western edge of Mohawk Township. The available records of materials encountered in the deep wells do not give reliable information about the stratigraphic position of the water-bearing beds, but presumably this sandstone where present, or sandy zones near the base of the Little Falls dolomite, comprises an important acquifer. The supply well (Mt 47) of Palatine Bridge probably obtains much of its water from this horizon.

Little Falls dolomite.—The Little Falls dolomite, called the "Calciferous sandrock", in early reports, is a light to dark-gray crystalline and subcrystalline dolomitic limestone that occurs generally in massive beds ranging from 0.5 to 2 feet in thickness. Certain beds contain abundant nodules and seams of gray and black chert, and other beds are quite sandy. The weathered dolomite characteristically has a sandy appearance, but only a few of the strata contain large amounts of sand. In addition to irregular nodules of calcite the formation has drusy cavities or vugs containing calcite and quartz crystals, the latter called Herkimer County diamonds which are almost perfect doubly terminated water-clear specimens eagerly sought by collectors. Seemingly, silica was precipitated in the cavities first, and subsequently calcite crystallized in part of the remaining space.

Insoluble residues of representative samples of the Little Falls dolomite consistently include large percentages of white dolocastic chert (chert replacing dolomite crystals) together with characteristic but minor quantities of green dolocasts. Quartz grains are of two types: large well-rounded (and generally spheroidal) frosted grains and small subangular frosted grains. Pyrite and shale are lacking.

The Little Falls dolomite was originally described from exposures along the Mohawk River at Little Falls in Herkimer County, and subsequently was also recognized to extend into the Champlain Valley east of the Adirondacks. The formation is 74 to 124 feet thick in Hamilton County, 160 to 200 feet thick in the Broadalbin quadrangle in Fulton and Saratoga Counties, and 300 to 400 feet at Saratoga Springs. In Montgomery County the dolomite is exposed over wide areas north of the Mohawk River and locally along the bluff south of the river. The upper and lower boundaries were not observed in the same locality but the thickness is at least 300 feet along this bluff.

The massive layers of the Little Falls dolomite are relatively dense and impermeable in themselves, but water moves readily through openings along joints and bedding planes. Commonly, such openings are enlarged appreciably by solution of the calcareous rock by water containing dissolved carbon dioxide. Large solution caverns, however, have not been noted in Montgomery County. The yield of wells in this formation varies somewhat erratically in relation to the number and size of the water-bearing channels that are intercepted by the well.

Most of the wells obtain adequate supplies of water for stock and domestic use from the Little Falls dolomite at depths ranging from 70 to 120 feet, although larger quantities of water may be obtained from wells several hundred feet deep. Where several hundred thousand gallons of water a day are desired, the yield of wells in calcareous formations may be increased appreciably by treatment of the well with hydrochloric acid to enlarge the openings, or by a properly placed charge of explosives to develop crevices that may reach nearby water-

bearing channels. Use of explosives, however, may result in destruction of the well or in loss of the supply previously obtained. Chemical analyses of water from the Little Falls dolomite are given in table 8 and figure 7.

Ordovician System

Tribes Hill limestone.—Unconformably overlying the Little Falls dolomite is an alternating series of massive medium-gray sugary dolomites, dark-blue fine-grained limestones, and a dark-gray to black slightly sandy limestone. This formation is distinguished from the underlying Little Falls dolomite by the preponderance of limestone over dolomite and the occurrence of fine-grained limestones that weather light blue. The operculum (plate used for closing the shell) of the gastropod *Ophileta* is characteristic of the Tribes Hill limestone in Montgomery County. These beds resemble the limestones of the overlying Lowville limestone, and seem to have been erroneously identified as Lowville in some early reports. Many of the beds weather to a characteristic fretwork appearance that originally caused the formation to be called the "fucoidal limestone."

Insoluble residues of the Tribes Hill limestone comprise abundant white to gray dolocasts that may be coarse or fine and lacelike. A few samples contained distinctive waxy black chert. Quartz grains, which may be lacking, are mostly small and angular but rarely a few rounded and frosted grains occur. Most of the samples also contained particles of dark shale as well as octahedrons and irregular masses of pyrite.

Goldring (1931, p. 270) reports that the Tribes Hill limestone occurs south and west of the Adirondack Mountain area, but it has not been identified in the Champlain Valley. The limestone is about 40 feet thick near Tribes Hill, the type locality, and its thickness does not differ notably in sections observed throughout the county.

These beds are present throughout the county immediately between the Little Falls dolomite and the Lowville or Glens Falls limestones. On the geologic map (pl. 2) the Tribes Hill limestone is mapped with the Little Falls dolomite. These two formations have about the same topographic expression and water-bearing properties.

The Tribes Hill limestone comprises the upper part of the "Calciferous limestone or sandrock" of the early reports on the Mohawk Valley (Vanuxem, 1842), and in general it represents deposition under similar conditions and in essentially the same area. Discovery of typical Lower Ordovician fossils, such as *Eccyliomphalus multiseptarius* and *Dalmanella* (?) *wemplei*, however, resulted in the identification of an unconformity between the Tribes Hill and the Cambrian Little Falls dolomite (Ulrich and Cushing, 1910). On the basis of faunal evidence, the Tribes Hill is probably equivalent to part of Division B of the Beekmantown sedimentary rocks (Ulrich and Cushing, 1910, p. 780).

The Tribes Hill furnishes small supplies of water to shallow drilled wells, but most wells penetrate and obtain water also from the overlying limestones and the Little Falls dolomite below. Therefore, data regarding the occurrence of water in the Little Falls dolomite apply also to the Tribes Hill limestone.

Lowville limestone.—The Lowville limestone is separted readily from the underlying Tribes Hill limestone by its pure, fine-grained or lithographic character and the dove color that weathers to a typical ashen gray. Locally, thick-bedded dove-colored limestone is intercalated with subcrystalline dark-gray to black limestone. Numerous vertical worm tubes filled with calcite give a prominent spotted appearance to these beds and readily explain the term "Birdseye limestone" that has been applied to them. Insoluble residues of the Lowville limestone include relatively small amounts of granular pyrite, light-gray shale, and small subrounded frosted and clear quartz grains. The following is a section of the Lowville limestone along a creek on the south side of the Mohawk River, about 1.25 miles southeast of Amsterdam.

	Thickness (feet)
Amsterdam limestone	
9. Limestone, dark-gray, medium-bedded; contains *Streptelasma.* Unconformity at base	
Lowville limestone	
8. Limestone, lithographic, dove-gray; contains *Tetradium*	0.6
7. Shale, sandy, nodular	.1
6. Limestone, light-gray, sandy, medium-bedded; sandy conglomerate in upper part	.8
5. Limestone, hard, gray, nodular and sandy	.3
4. Limestone, light-gray, argillaceous	.1
3. Limestone, gray, nodular; weathers shaly	2.0
2. Limestone, light bluish gray; weathers white; lithographic	1.7
Tribes Hill limestone	
1. Limestone, massive, gray; weathers buff	

The Lowville limestone is present in sections seen in eastern Montgomery County, but it disappears between Fultonville and Sprakers on the east flank of the Adirondack arch. The Lowville is lacking also at Canajoharie and west of Palatine Bridge to the vicinity of St. Johnsville, where they reappear. The thickness changes rapidly within short distances and rarely exceeds 3 feet. On the geologic map (pl. 2) the Lowville limestone is mapped with the Amsterdam and Glens Falls limestones.

The beds in Montgomery County that are assigned to the Lowville limestone may be correlated readily with the Lowville limestone of the type region in Lewis County, New York, on the basis of the distinctive color when fresh and weathered, the lithographic texture, and the abundance of the worm tubes called *Phytopsis tubulosum.* Also, characteristic Lowville fossils, such as *Tetradium cellulosum* (Hall) and *Leperditia fabulites* were observed at several outcrops in the county.

The Lowville unconformably overlies the Tribes Hill limestone and unconformably underlies the Amsterdam limestone or the Glens Falls limestone where the Amsterdam is absent. Early writers considered the Lowville limestone to be separate from overlying beds assigned to the Black River limestone, but later assignment of the formation to the base of the Black River group has been followed by most workers (Kay, 1937).

The Lowville limestone is relatively thin, so that it does not constitute an important water-bearing formation in this county. The massive limestone layers are relatively impervious, but water may enter uncased wells through openings along joints and bedding planes.

Amsterdam limestone.—The Amsterdam limestone includes a variable thickness of pure massively bedded gray to black limestone that ranges from dense to coarsely crystalline. Many of the beds have a characteristic rough hackly fracture. The formation rests with a distinct unconformity on the Lowville limestone, and several thin beds of conglomerate occur commonly near the base. The pebbles include fragments from the underlying Lowville and Tribes Hill limestones and the Little Falls dolomites. In eastern Montgomery County 2- to 4-inch beds of fine grayish-blue lithographic limestone occur intercalated between darker limestone. Specimens of the colonial coral *Columnaria* occur typically just above the lower contact, and these aid in the identification of this formation. The following is a section from the Tribes Hill limestone to the Glens Falls limestone along Terwilleger Creek, about 2.5 miles southeast of Amsterdam.

	Thickness (feet)
Glens Falls limestone (Larrabee limestone member of Kay)	
8. Limestone, light-gray, thin- to medium-bedded, crystalline	2.2
7. Limestone, thin-bedded, gray, coquinal, contains ostracods, gastropods, crinoid columnals, *Strophomena*	6.8
6. Limestone, hard, dark-gray, massive. Unconformity at base	1.2
Amsterdam limestone	
5. Limestone, dark-gray, thick-bedded, base nodular; contains *Streptelasma* and *Rafinesquina*	8.5
Lowville limestone	
4. Limestone, dark-gray, weathers light blue, lithographic, massive	1.7
3. Limestone, medium-grained, dark-gray	.2
2. Limestone, dolomitic, argillaceous, platy. Unconformity at base	.1
Tribes Hill limestone	
1. Limestone, dolomitic, has light sugary texture, weathers gray	

The Amsterdam limestone is not readily separated from the overlying Glens Falls limestone at all localities in the county, but it seems to thin rapidly to the west from about 11 feet near the type locality at Amsterdam to 4 feet at Fultonville. It is not identified farther west at Sprakers, Canajoharie, and St. Johnsville. Northeastward in the Champlain Valley the Amsterdam limestone reaches a thickness of over 20 feet.

The Amsterdam, between the Lowville and typical beds of Trenton age, was termed the Mohawk limestone by Conrad (1839), but later it was renamed the Amsterdam limestone by Cushing (1911) for characteristic exposures near the city of Amsterdam. The formation rests unconformably on the Lowville limestone in eastern Montgomery County, but westward and in the vicinity of Saratoga it overlies the Tribes Hill limestone.

Although the Amsterdam limestone is generally similar in stratigraphic position, lithology, and faunal character to the Watertown limestone of the western part of the Mohawk Valley and the Black River Valley, the Amsterdam has been considered to be a slightly younger, uppermost unit of the Black River group (Goldring, 1931). Kay (1937, p. 260), however, tentatively includes the Amsterdam in the lower part of the Trenton group. Fossils, including species of *Columnaria, Streptelasma* (?), *Rhynchotrema, Strophomena,* and *Zygospira,* are relatively common, but they do not permit definite placement of the formation.

The records of wells in Montgomery County do not distinguish the Amsterdam limestone from other limestones just above and below. Seemingly, however, joints and bedding planes yield small supplies of water to shallow wells, and in uncased wells water is added to the supply obtained from the deeper aquifers. In general, the Amsterdam limestone does not constitute an important source of water in the county.

Glens Falls limestone.—The Glens Falls limestone was proposed to include basal beds of the Trenton group southeast and northeast of the Adirondacks that are older than limestones exposed at Trenton Falls, Herkimer County, and younger than the Amsterdam limestone (Ruedemann, 1912). Kay (1937) redefined the Glens Falls limestone largely on faunal data to include his Larrabee limestone member at the base and the calcareous shale of his Shoreham member above. In Montgomery County, however, the Larrabee member is not separated readily from the Amsterdam limestone, and on the Adirondack arch at Sprakers and Canajoharie the Glens Falls limestone is lithologically and faunally intermediate between the two members distinguished elsewhere.

The crystalline Larrabee limestone member grades up into Kay's Shoreham member by an increase in the number and thickness of the intercalated shale layers, and by a reduction in the limestone. At sections exposed in eastern Montgomery County this change in lithology occurs in about 5 feet of the formation, but on the Adirondack arch the Glens Falls limestone consists of about 17 feet of crystalline limestone of typical Larrabee lithology intercalated with black shale and black calcareous siltstones. Kay (1937) classifies the strata of the Glens Falls limestone at Sprakers and Canajoharie as belonging to the Shoreham member,

partly because of the occurrence of the characteristic Shoreham bryozoan, *Prasopora orientals* Ulrich. The beds, however, lack the trilobite *Cryptolithus tesselatus* Green, which is characteristic of the Shoreham member elsewhere. The following is a section of the Tribes Hill and Glens Falls limestones along Canajoharie Creek south of Canajoharie.

	Thickness (feet)
Canajoharie shale	
13. Shale, black, fissile; contains ostracods and pyritized fossils such as *Strophomena*	
Glens Falls limestone	
12. Limestone, medium-grained, contains rounded discoidal black and gray limestone pebbles, black shale partings, *Prasopora*	0.6
11. Limestone, medium-bedded, gray, crystalline, coquinal, contains *Prasopora, Bathyurus, Encrinurus,* and *Hesperorthis*	1.8
10. Limestone, medium-bedded, coquinal; black shale partings	.4
9. Limestone, thick- to medium-bedded, gray, crystalline	3.1
8. Shale, black, alternating with black argillaceous limestone and gray coquinal limestone	5.6
7. Limestone, gray, crystalline, and black, argillaceous, with flat pebbles and ripple marks; alternating beds of black calcareous siltstone, *Isotelus, Encrinurus Calymene, Strophomena,* ramose bryozoa, and large orthoceratids. Unconformity at base	5.8
Tribes Hills limestone	
6. Limestone, dolomitic, massively bedded, sugary texture, light-gray	3.9
5. Limestone, thin- and medium-bedded, fucoidal, dark-gray, mottled, weathers bluish gray, slightly sandy	15.8
4. Limestone, bluish-gray, weathers light blue, thin-bedded, sandy streaks, argillaceous zones, massive bluish fucoidal limestone at base	39.1
3. Limestone, massive, medium-grained, light-gray, weathers buff	2.3
2. Limestone, massive, bluish-gray, weathers blue, fucoidal	4.8
1. Limestone, thin-bedded, conglomeratic, gray, medium-grained	3.9
Little Falls dolomite (?)	

Ruedemann originally described the section at Glens Falls, Warren County, as the type locality of this formation, but he indicated that the beds at Sprakers contributed importantly to the recognition of the formation. Seemingly, these beds then represent a facies alternating between Larrabee and Shoreham conditions and covering the time interval of at least part of each member. Subdivisions of the Glens Falls limestone, therefore, are not aplicable to the section at Sprakers and Canajoharie.

The Glens Falls limestone, like the underlying Amsterdam and Lowville limestones, is not an important water-bearing formation alone, but it may contribute water to uncased wells that penetrate it to reach deeper formations. The water-bearing properties of the Shoreham member are essentially similar to those of the overlying Canajoharie shale, except that the concentration of hydrogen sulfide gas may be greater.

Canajoharie and Utica shales.—In most of Montgomery County the unconsolidated deposits are underlain by a monotonous sequence of black clay shales that have been subdivided into two formations and several members by means of the graptolite fauna. These units, however, are not recognized readily at most localities or in well records, and the water-bearing properties and other physical features are so very similar that the Canajoharie shale below and Utica shale above are treated here as a single unit.

The Canajoharie and Utica shales comprise black uniformly fine grained or, more rarely, silty calcareous shale beds that range from thin sheets to nearly a foot in thickness. The residue after treatment with acid is a finely divided mass of soft dark shale and carbonaceous matter, usually pyrite, and rarely sand grains. Aside from the numerous graptolites, the fossils include small brachiopods, cephalopods, ostracods, and the characteristic trilobite *Triarthrus becki* Green.

As shown on the geologic map (pl. 2) the Canajoharie and Utica shales occur in most of the county south of the Mohawk River and also in important areas to the north. The total thickness of these black shales was not measured in a single section, but studies by Ruedemann (1912) and Kay (1937) indicate that the thickness approaches 2,000 feet where the uppermost beds have not been removed by erosion.

The fauna of the Canajoharie shale indicates that this particular part of the shales is equivalent in age to calcareous beds of Trenton age in the western part of the Mohawk Valley, and gives way eastward to the Schenectady formation. The Utica shale is of upper Trenton age and is approximately equivalent to Raymond's Cobourg limestone and Collingwood formation and Gloucester formations of the Thousand Island region. The interrelationships of these facies of the Trenton along the Mohawk Valley is reviewed in detail by Kay (1937).

The black shales are considered reliable sources of small to moderate water supplies because of numerous and relatively uniformly distributed joints and bedding planes along which water may move. Although large supplies rarely are obtained from these shales, most of the shallow wells are little affected by droughts. As in the calcareous formations, the use of moderate charges of explosives may open up cracks for the entrance of additional water where the original supply was inadequate. The wells range in depth from about 80 to 350 feet, but a majority of wells obtain their supplies of water within 125 feet of the surface.

Much of the water from these formations is moderately high in iron and contains objectionable quantities of hydrogen sulfide gas. Chemical analyses of water from the Canajoharie and Utica shales are given in table 8 and figure 8.

Schenectady formation.—The black Canajoharie and Utica shale unit gives way upward abruptly and grades eastward into alternating beds of fine-grained blue-gray sandstone and black to olive-gray platy shale. The shale beds become more arenaceous and the sandstones more prominent and massive in the upper part of the formation in Montgomery County. Many of the sandstones are cross-bedded and lenticular in form so as to suggest deposition in relatively shallow water.

The Schenectady formation is well exposed in the bluff along Schoharie Creek near the southern border of Montgomery County and in a few outcrops in the uplands in the southern part of the county. Its thickness is in excess of 1,500 feet to the east in Schoharie County, but it is more than a few hundred feet in thickness only in the higher parts of Montgomery County. Inasmuch as the consolidated rock formations are covered by drift, and exposures are relatively rare in the upland portions of the county, plate 2 indicates the distribution of the Schenectady formation only approximately.

The Schenectady formation was named by Reudemann (1912) from exposures near Schenectady to include the sandy shale and sandstones overlying the Canajoharie shale. Previously these beds had been assigned to the Frankfort shale or to the "Hudson River" shale, but Ruedemann's study of the graptolites indicated that the Schenectady is older than the Frankfort shale of the Utica region.

The seaweed *Sphenophycus latifolius* (Hall) occurs commonly throughout the Schenectady together with a few eurypterids and numerous graptolites, such as *Climacograptus typicalis* (Hall), in the shale layers. The fauna includes types that occur in other formations of Trenton age, so that Kay (1937) suggests that this formation probably represents an eastward, shoreward facies of the Canajoharie shale.

The Schenectady formation yields small supplies of water to drilled wells and springs in the southern part of Montgomery County, but the low permeability of the sandstone layers, which is due to the poor sorting and considerable cementation, and the occurrence of the beds chiefly on the higher hills, precludes extensive water-supply development.

Frankfort shale.—Kay (1937) recognized graptolites that indicate a Frankfort or Upper Ordovician age for some of the black shales of the southwestern part of Montgomery County. This unit, however, is lithologically similar to underlying beds in the upper part of the Trenton group, and it is not identified from well records or in the few exposures. Therefore, no attempt is made in this report to distinguish the Frankfort shale, whose lithologic and hydrologic character in this county is similar to that of similar subjacent formations.

CENOZOIC ROCKS

Quaternary System

Pleistocene series.—As the thick Pleistocene ice sheet advanced, weathered soils were stripped off and the underlying rocks were differentially eroded. This accumulated rock debris was dropped subsequently when the ice melted, and it comprises the unconsolidated clays, sands, gravels, and mixed materials that now form a veneer over most of the county. Studies elsewhere in New York State and in New Jersey and Pennsylvania indicate that this area underwent several major periods of ice advance and retreat. The latest or Wisconsin ice advance, however, destroyed or masked essentially all deposits of previous glaciation.

Pleistocene series—Glacial till.—The rock debris released directly by melting of ice without appreciable sorting by water is termed till. This is a heterogeneous accumulation of unstratified fresh impure clay and angular rock fragments ranging greatly in size and shape. Much of the rock in the tills of Montgomery County is derived from the underlying consolidated formations, but crystalline and other rocks from the Adirondacks and probably farther north are present. In the parts of the county underlain by black Ordovician shales, the tills are very dark and are composed largely of clay. The limestone areas, on the other hand, yield a sandy till that contains numerous calcareous pebbles.

Till occurs at the surface over most of Montgomery County except along the major stream valleys (fig. 11). Locally, as along the bluffs of the Mohawk River, till occurs beneath a different thickness of water-laid gravel and sand. The thickness of the till ranges widely even within relatively small areas. Comparatively thin deposits of till occur on the uplands north of the Mohawk River on the higher level areas. The thickness ranges from about 50 to 150 feet in the massive tills extending along the north slope of the Mohawk River bluffs from the eastern border of the county about to Fonda, and westward from St. Johnsville. Other thick deposits of till were observed along Auries Creek in Glen Township, in southeastern Florida and Southern Canajoharie Townships, and along the lower valley of Schoharie Creek.

Tills commonly are relatively impermeable, and like clay yield water very slowly. The quantities of water obtained from till depend upon the proportion of coarse material to clay, so that wells in the till overlying the black shales are less satisfactory than wells entering the more permeable tills in the limestone areas. Large-diameter dug wells are especially effective in recovering water from till deposits, inasmuch as a relatively large supply of water is stored in the well for immediate use. Then the water is replaced very slowly during a subsequent period when the well is not used.

More permeable lenses or local layers of stratified sand and gravel occur within some thick tills or immediately between the base of the till and the underlying consolidated rock formations. Doubtless many of the wells dug or drilled into till obtain water from such layers. Where till is overlain by permeable material, as along the lower valley of Schoharie Creek, Auries Creek, and the northern bluff of the Mohawk River Valley, areas having a perched water table may be quite extensive.

Pleistocene series—Glacial lake and stream deposits.—Large streams of meltwater that flowed away from the ice masses carried considerable quantities of rock debris that were deposited as sorted layers of stratified sand and gravel when the velocity of the water decreased. Finer-grained stratified sand and clay were laid down in temporary lakes that were formed where glacial ice or till deposits blocked drainage channels. These lake and outwash deposits range from clay and silt to coarse gravel, and permeable beds are relatively common. The gravels consist of a variable percentage of well-rounded pebbles and boulders that are embedded in sand and silt (table 9).

The outwash deposits occur chiefly as scattered shoulders overlying till along both banks of the Mohawk River Valley and extending up some of the tributary valleys. Relatively fine-grained water-laid sediments occur on either side of the Mohawk River at Amsterdam and intermittently in a narrow belt along the bluffs to Tribes Hill. The flat terrace at Tribes Hill, however, is underlain by some coarser sand and gravel. Between Auriesville and Fultonville is an area of about 5 square miles underlain by silts and clays in which permeable deposits occur locally. The following is a section of glacial deposits along Auries Creek, 2 miles southwest of Glen.

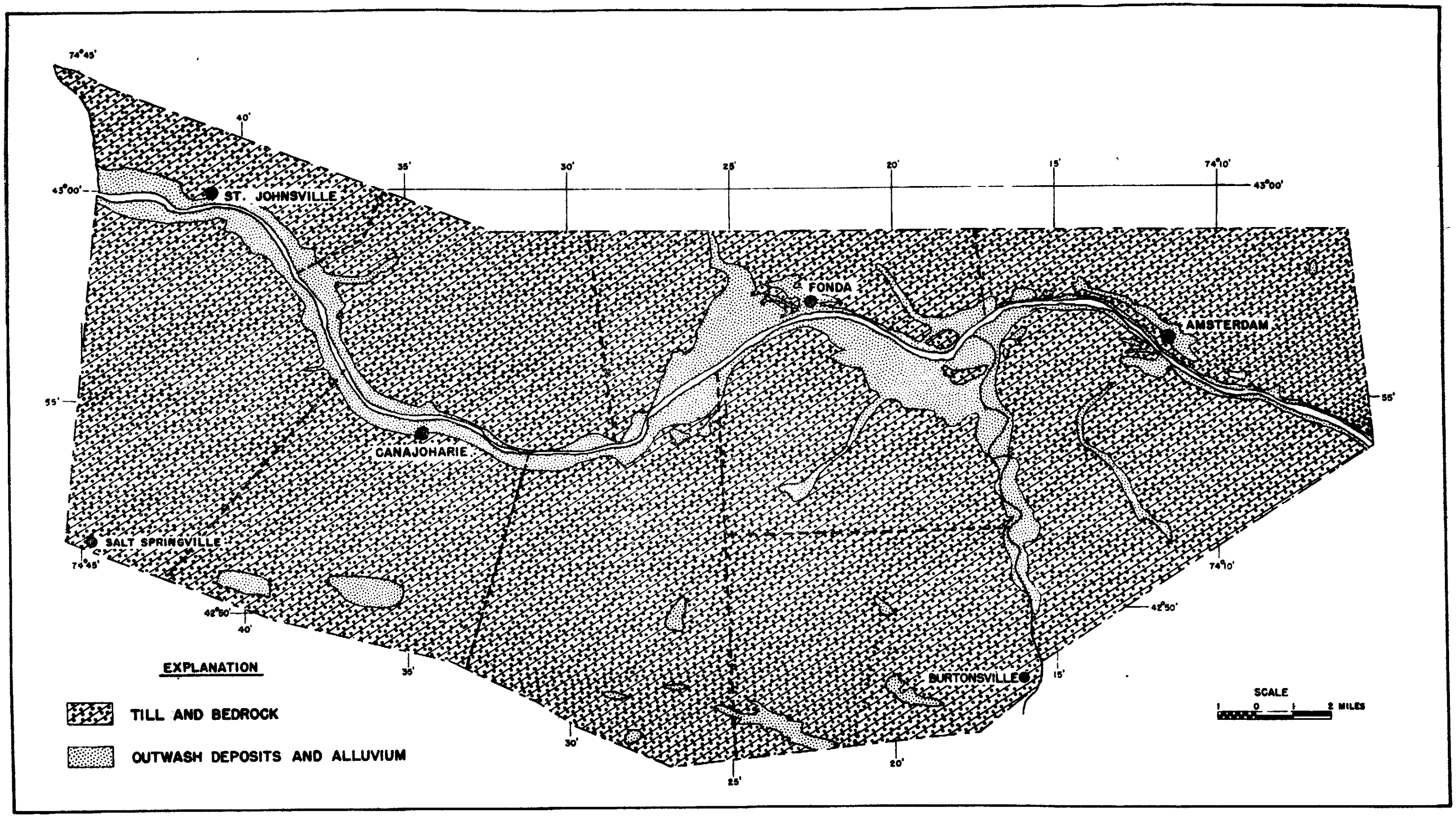

Figure 11.—Map of Montgomery County showing areal distribution of glacial till and outwash deposits.

Table 9.—Mechanical analyses of unconsolidated sand and gravel in Montgomery County.

Sample No.	Mechanical analysis (percent by weight[a])									
	Very coarse gravel (Larger than 16.0 mm)	Coarse gravel (16.0 mm to 8.0 mm)	Medium gravel (8.0 to 4.0 mm)	Fine gravel (4.0 to 2.0 mm)	Very coarse sand (2.0 to 1.0 mm)	Coarse sand (1.0 to 0.5 mm)	Medium sand (0.5 to 0.25 mm)	Fine sand (0.25 to 0.125 mm)	Very fine sand (0.125 to 0.062 mm)	Silt and clay (less than 0.062 mm)
1	13.04	7.14	6.93	1.50	17.21	39.86	12.14	1.53	0.36	0.29
2	——	——	——	.02	.11	1.23	22.71	60.40	12.95	2.58
3	5.38	5.14	4.92	1.24	10.42	31.79	28.93	9.17	2.33	.68
4	17.67	8.84	14.07	2.30	13.82	17.68	16.85	6.37	1.75	.65

Sample 1. Pleistocene terrace gravel from pit at eastern edge of Tribes Hill.

Sample 2. Recent sand from alluvial terrace overlying till along Schoharie Creek, about 2.5 miles south of Mill Point.

Sample 3. Pleistocene terrace gravel from pit about 2 miles east of Canajoharie on the north side of the Mohawk River.

Sample 4. Recent gravel from alluvial terrace along Carroga Creek.

[a] Size classification is that of Jeffords, R. M., West Va. Geol. Survey Bull. 10, p. 17.

	Thickness (feet)
Pleistocene water-laid deposits and till	
4. Soil and silty clay	2.0
3. Clay, varved; clay layers ¼ inch thick, silty layers 1 to 2 inches thick; ice-rafted pebbles	4.7
2. Till, reworked and washed	.5
1. Till, blue	18 +

Another area of glacial outwash gravel forms the broad terrace called the Sand Plains, which extends about 5 miles north from Fonda. Yellow silts are exposed at many points at the surface, but well records indicate that important gravel deposits occur below the surface. Other isolated shoulders of these gravels occur on the north side of the Mohawk River westwards to the county line. Another extensive terrace deposit of coarse gravel is exposed in the bluffs in the vicinity of Midenville.

Sands and gravels usually yield large quantities of water to properly constructed wells, although perforated casings, well screens, or gravel-well construction are required commonly to develop sand-free water in adequate quantity. Domestic supplies of water are obtained readily at Tribes Hill by means of small-diameter driven wells, and a larger supply is developed near Fort Plain from a screened drilled well. Many of the terraces along the Mohawk Valley (fig. 17) doubtless are underlain by very permeable sands and gravels, but there have been relatively few attempts to develop moderately large supplies at such places.

The water in these unconsolidated materials generally is moderately hard and it may contain objectionable amounts of iron. Locally, more heavily mineralized water in subjacent consolidated formations moves upward into the more permeable sand so that objectionable amounts of hydrogen sulfide, iron, and other constituents may occur.

Recent series—Alluvium, mantle rock, and soil.—Deposits of geologically recent times include sand and silt along the broad valley flats, and a variable thickness of soils and mantle rocks scattered elsewhere over the county. These materials are formed by decomposition and disintegration of the underlying rock formations and commonly have not been transported far. Fine-grained sediments, however, are left by flood waters along the lowlands bordering the major streams and locally at the base of eroded slopes.

These sediments are comparatively thin in Montgomery County. Locally, however, small supplies of water sufficient for domestic and stock use are obtained by means of dug wells. These wells should be located where the permeable material is thickest and where the greatest area will be drained. Special precautions should be taken to guard against bacterial pollution.

REFERENCES

Adams, C. C., 1937, *Thirty-first report of the director of the Division of Science and State Museum*: New York Mus. Bull. 313, pp. 1-140, figs. 1-27.

Brigham, A. P., 1898, *Topography and glacial deposits of the Mohawk Valley*: Geol. Soc. America Bull. Vol. 9, pp. 183-210, 2 figs.

——————, 1929, *Glacial geology and geographic conditions of the lower Mohawk Valley*: New York State Mus. Bull. 280, pp. 1-133, figs. 1-72.

Cleland, H. F., 1900, *The Calciferous of the Mohawk Valley*: Bull. Am. Paleontology, vol. 3, pp. 1-26, pls. 13-17.

——————, 1903, *Further notes on the Calciferous (Beekmantown) formation of the Mohawk Valley, with description of new species*: Bull. Am. Paleontology, vol. 4, pp. 1-24, pls. 1-4.

Conrad, T. A., 1837, *First annual report on the geological survey of the third district of the State of New York*: New York Geol. Survey 1st Ann. Rept., pp. 155-186.

——————, 1839, *Second annual report on the paleontological department of the survey*: New York Geol. Survey 3d Ann. Rept., pp. 57-66.

Cook, J. H., 1924, *The disappearance of the last glacial ice sheet from eastern New York*: New York State Mus. Bull. 251, pp. 158-176, fig. 1.

Cooper, H. H., Jr., and Jacob, C. E., 1946, *A generalized graphical method for evaluating formation constants and summarizing well-field history*: Am. Geophys. Union Trans., vol. 27, pp. 526-534, 5 figs.

Cumings, E. R., 1900, *Lower Silurian system of eastern Montgomery county, New York*: New York State Mus. Bull. 34, pp. 419-468, 7 figs., map.

Cushing, H. P., 1905, *Geology of the vicinity of Little Falls, Herkimer County*: New York State Mus. Bull. 77, pp. 1-98, pls. 1-15, 2 maps.

——————, 1911, *Nomenclature of the lower Paleozoic rocks of New York*: Am. Jour. Sci., 4th ser., vol. 31, pp. 135-145.

Dana, J. D., 1863, *On the existence of a Mohawk Valley glacier in the glacial epoch*: Am. Jour. Sci., 2d ser., vol. 35, pp. 243-249.

Darton, N. H., 1894, *Geology of the Mohawk Valley in Herkimer, Fulton, Montgomery, and Saratoga counties*: New York State Mus. 47th Ann. Rept., pp. 601-623.

Dean, H. T., 1936, *Chronic endemic dental fluorosis*: Am. Med. Assoc. Jour., vol. 107, pp. 1269-1272.

——————, 1941, Jay, Phillip, Arnold, F. A., Jr., and Elvove, Elias, 1941, *Domestic water and dental caries*: U. S. Pub. Health Repts., vol. 56, pp. 761-792.

Depart. Commerce, Albany, 1946 *New York State means business in the Mohawk Valley area*: pp. 1-27 figs.

Eaton, Amos, 1824, *A geologic and agricultural survey of the district adjoining the Erie Canal in the State of New York*: pp. 1-163, Albany.

Emmons, Ebenezer, 1838, *Report of the second geological district of the State of New York*: New York Geol. Survey 2d Ann. Rept., pp. 185-252.

Fairchild, H. L., 1912, *The glacial waters in the Black and Mohawk Valleys*: New York State Mus. Bull. 160, pp. 1-48.

Fuller, M. L., and others, 1904, *Contributions to the hydrology of eastern United States, 1903*: U. S. Geol. Survey Water-Supply Paper 102.

——————,1905, *Contributions to the hydrology of eastern United States, 1904*: U. S. Geol. Survey Water-Supply Paper 110.

Garver, H. L., 1946, *Safe water for the farm*: U. S. Dept. Agr. Farmer's Bull. 1978, pp. 1-46, figs. 1-22.

Goldring, Winifred, 1929, *Handbook of paleontology for beginners and amateurs, part 1, The fossils*: New York State Mus. Handbook 9, pp. 1-356, figs. 1-57.

————, 1931, *Handbook of paleontology for beginners and amateurs, part 2, The formations*: New York State Mus. Handbook 10, pp. 1-488, figs. 1-62.

Hall, James, 1847, *Description of the organic remains of the lower division of the New York System (equivalent to the lower Silarian rocks of Europe)*: Paleontology of New York, vol. 1, pp. 1-338, pls. 1-99, Albany.

Hill, F. F., and Blanch, G. T., 1934, *An economic study of land utilization in Montgomery County, 1932*: Cornell Univ. Agr. Exper. Sta., Bull. 613, pp. 1-50, figs. 1-6, map.

Jeffords, R. M., 1945, *Ground-water conditions along the Ohio Valley at Parkersburg, W. Va.*: West Virginia Geol. Survey Bull. 10, pp. 1-57, figs. 1-19.

Kay, G. M., 1937, *Stratigraphy of the Trenton group*: Geol. Soc. America Bull., vol. 48, pp. 233-302, pls. 1-10, figs. 1-13.

————, 1942, *Development of the northern Allegheny synclinorium and adjoining regions*: Geol. Soc. America Bull., vol. 53, pp. 1601-1658, pls. 1-3, figs. 1-11.

Kemp, J. F., and Hill, B. F., 1901, *Preliminary report on the pre-Cambrian formations in parts of Warren, Saratoga, Fulton, and Montgomery Counties*: New York State Mus. 53d Ann. Rept., pp. 17-35.

Lee, Ora, and Lounsbury, Clarence, 1911, *Soil survey of Montgomery County, New York*: U. S. Dept. Agr. Bur. Soils 10th Ann. Rept. Field Operations, pp. 159-196, map.

McQueen, H. S., 1937, *Economic application of the insoluble residue method*: Am. Inst. Min. Met. Eng. Trans., vol. 126, pp. 530-540.

Megathlin, G. R., 1938, *Faulting in the Mohawk Valley*: New York State Mus. Bull. 315, pp. 85-122, figs. 25-30.

Meinzer, O. E., 1923, *The occurrence of ground water in the United States, with a discussion of principles*: U. S. Geol. Survey Water-Supply Paper 489, pp. 1-321, pls. 1-31, figs. 1-110.

Merrill, F. J. H., 1901, *Geologic map of the State of New York*: New York State Museum, Albany.

Miller, W. J., 1911, *Geology of the Broadalbin quadrangle, Fulton-Saratoga Counties, New York*: New York State Mus. Bull. 153, pp. 1-65, map.

————, 1924, *The geological history of New York State*: New York State Mus. Bull. 255, pp. 1-148, pls. 1-52, figs. 1-39.

Mordoff, R. A., 1934, *The climate of New York State*: Cornell Univ. Agr. Exper. Sta. Bull. 444 (rev.), pp. 1-99, figs. 1-64.

Prosser, C. S., 1900, *Notes on stratigraphy of Mohawk Valley and Saratoga County, New York*: New York State Mus. Bull. 34, pp. 469-484, 7 figs.

————, and Cumings, E. R., 1897, *Sections and thicknesses of the Lower Silurian formations on West Canada Creek and in the Mohawk Valley*: New York Geol. Survey 15th Ann. Rept., pp. 23-24, 615-659.

Quinn, A. W., 1933, *Normal faults of the Lake Champlain region*: Jour. Geology, vol. 41, pp. 113-143, figs. 1-15.

Quirke, T. T., and Collins, W. H., 1930, *The disappearance of the Huronian*: Canada Geol. Survey Mem. 160, pp. 1-129, pls. 1-7, figs. 1-4, 4 maps.

Raymond, P. E., 1912, (Report of the) *Paleontological division; invertebrate*: Canada Geol. Survey Summary Rept. for 1911, pp. 351-357.

———, 1916, *Expedition to the Baltic provinces of Russia and Scandinavia; part 1, The correlation of the Ordovician strata of the Baltic basin with those of eastern North America*: Harvard Coll. Mus. Comp. Zool. Bull., vol. 56, geol. ser. no. 38, pp. 179-286.

———, 1921, *A contribution to the description of the fauna of the Trenton group*: Canada Geol. Survey Mus. Bull. 31, pp. 1-64;, 11 pls.

Ruedemann, Rudolf, 1912, *The lower Siluric shales of the Mohawk Valley*: New York State Mus. Bull. 162, pp. 1-151, pls. 1-15, figs. 1-25.

———, 1925, *The Utica and Lorraine formations of New York, part 1, Stratigraphy*: New York State Mus. Bull. 258, pp. 1-175, pls. 1-7, figs. 1-10.

———, and Chadwick, G. H., 1935, *Ordovician black shales of New York*: Science, new ser., vol. 81, p. 400.

Theis, C. V., 1935, *The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage*: Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Ulrich, E. O., and Cushing, H. P., 1910, *Age and relationships of the Little Falls dolomite (calciferous) of the Mohawk Valley*: New York State Mus. Bull. 140, pp. 97-140.

Vanuxem, Lardner, 1838, *Second annual report of so much of the geological survey of the third district of the State of New York as relates to the objects of immediate utility, Montgomery County*: New York Assembly Doc. 200, pp. 257-266.

———, 1839, *Third annual report of the geological survey of the third district*: New York Geol. Survey 3d Ann. Rept., pp. 241-285.

———, 1840, *Fourth annual report of the geological survey of the third district*: New York Geol. Survey 4th Ann. Rept., pp. 355-383.

———, 1841, *Fifth annual report of the geological survey of the third district*: New York Geol. Survey 5th Ann. Rept., pp. 137-147.

———, 1842, *Geology of New York, part 3, comprising a survey of the third geological district*: pp. 1-306 Albany.

Wenzel, L. K., 1942, *Methods for determining permeability of water-bearing materials*: U. S. Geol. Survey Water-Supply Paper 887, pp. 1-192, pls. 1-6, figs. 1-17.

Table 10.—Logs of selected wells in Montgomery County

Logs of eight wells are listed in this table to indicate the character of the materials encountered in wells at scattered locations in Montgomery County. Relatively few detailed records are available for wells in the county, but information on many of the wells not listed here includes the depth to bedrock and the general character of the bed rock unit or units penetrated (table 11).

Mt 68. A. H. Dillenbeck, Fonda. About 3 miles northwest of Fonda. Altitude above mean sea level about 560 feet. Drillers log.

	Thickness (feet)	Depth (feet)
Sand	94	94
Gravel	2	96
Shale, black (Canajoharie and Utica shales)	74	170

Mt 75. Adam Wemple, Fonda. About 1⅛ miles northwest of Fonda. Bored well. Altitude above mean sea level about 380 feet. Driller's log.

	Thickness (feet)	Depth (feet)
Loam	4	4
Clay, yellow	2	6
Sand and gravel	17	23

Mt 81. School District 12, Fonda. Amout 1½ miles north west of Fonda. Altitude above mean sea level about 640 feet.

	Thickness (feet)	Depth (feet)
Soil	5	5
Shale (Canajoharie and Utica shales)	50	55
Limestone (Glens Falls limestone)	75	130

Mt 197. L. Countryman, Buel. About 6 miles southwest of Canajoharie. Altitude above mean sea level about 725 feet. Driller's log.

	Thickness (feet)	Depth (feet)
Clay	50	50
Clay, blue (till)	35	85
Slate (Canajoharie and Utica shales)	20	105

Mt 270. Auriesville Shrine, Auriesville. About 3 miles east of Fultonville. Altitude above mean sea level about 320 feet. Driller's log.

	Thickness (feet)	Depth (feet)
Hardpan and boulders	58	58
Clay	22	80
Clay and fine sand	22	102
Gravel and hardpan	13	115
Bedrock (Canajoharie and Utica shales)	38	153

Mt 271. Auriesville Shrine, Auriesville. About 3 miles east of Auriesville. Altitude above mean sea level about 400 feet. Abandoned well. Driller's log.

	Thickness (feet)	Depth (feet)
Sand and gravel	31	31
Till and boulders	41	72
Gravel	21	93
Till and boulders	49	142
Clay hardpan (till)	41	183
Shale (Canajoharie and Utica shales)	232	415
Limestone and sandstone (Little Falls dolomite)	100	515

Mt 309. William Bobilin, Fort Hunter. On Church Street about 0.25 mile southeast of post office. Altitude above mean sea level about 300 feet. Driller's log.

	Thickness (feet)	Depth (feet)
Clay and hardpan	90	90
Sand	12	102

Mt 329. Ernest Shuttleworth, Amsterdam. In village of Minaville. Altitude above mean sea level about 560 feet. Driller's log.

	Thickness (feet)	Depth (feet)
Sand	6	6
Clay, blue (till)	119	125
Shale, black (Canajoharie and Utica shales)	175	300

Table 11.—Records of selected wells in Montgomery County, New York

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 1	8U, 15.2S, 2.0E	F. B. Groff	720	Dug	12	24	..	Pleistocene till	8	None	..	Dom	Now used as U. S. Geological Survey observation well.[f]
Mt 2	8U, 15.0S, 1.6E	J. W. Davis	690	Dug	27	72	..	Pleistocene till	26	None	..	Dom	Well not in use.
Mt 3	8U, 15.3S, 1.6E	Arthur Hyde	600	Drl	43	6	8	Glens Falls and Amsterdam limestones	..	Suction	..	Farm	Well flows seasonally.
Mt 4	8U, 15.5S, 1.7E	E. O. Christman	680	Drl	76	6	..	Tribes Hill limestone	..	Suction	..	Farm	
Mt 5	8U, 15.8S, 0.8E	Laura Gilbert	460	Dug	14	..	..	Pleistocene till	10	Suction	..	Dom	
Mt 7	8U, 16.8S, 1.3E	Bert Klock	400	Dug	..	..	..	Pleistocene till	..	Suction	..	Dom	
Mt 9	8U, 15.4S, 2.3E	G. E. Bowers	760	Drl	42	6	..	Tribes Hill limestone	..	Force	..	Ind	Temperature 48°F.
Mt 11	8U, 16.9S, 2.3E	Daniel Van Vorst	360	Dug	18	..	..	Pleistocene gravel	15	Suction	..	Dom	
Mt 12	8U, 17.0S, 2.6E	A. Thompson	320	Drl	50	6	..	Pleistocene gravel	3	Suction	1.3	Dom	
Mt 13	8U, 16.7S, 2.8E	Frank Schoen	520	Drl	83	6	..	Little Falls dolomite	20	Jet	20	Dom	Temperature 50°F.
Mt 14	8U, 16.3S, 2.9E	M. Sponable	500	Drl	93	6	0	Little Falls dolomite	22	Jet	..	Dom	
Mt 16	8U, 15.9S, 3.4E	Alfred Hayes	700	Drl	40	6	..	Little Falls dolomite	20	Suction	..	Dom	
Mt 17	8U, 15.8S, 4.0E	Harold Richards	1,000	Dug	30	..	..	Pleistocene till	..	Suction	..	Dom	
Mt 18	8U, 15.9S, 4.0E	William Nagle	900	Dug	11	..	..	Pleistocene till	..	Suction	..	Farm	
Mt 19	8U, 16.2S, 3.7E	Victor Capic	800	Drl	100	6	..	Little Falls dolomite	38	Jet	..	Dom	([g])
Mt 20	8U, 16.3S, 3.6E	M. Johnson	600	Drl	24	6	10	Little Falls dolomite	15	Suction	..	Dom	
Mt 21	8U, 16.4S, 3.9E	J. Wilber	800	Drl	80	6	..	Little Falls dolomite	..	Suction	..	Dom	
Mt 22	8U, 0.3S, 3.6E	Palatine Dye Company	310	Drl	133	6	..	Pleistocene gravel	..	None	..	Ind	Well not in use. Two other similar wells at this location.
Mt 23	9U, 0.2S, 4.2E	Howard Nellis	320	Drl	83	6	..	Little Falls dolomite	..	Force	..	Dom	
Mt 24	9U, 0.9S, 6.2E	Elmer Sponable	580	Drl	212	6	8	Canajoharie and Utica shales	7	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 26	9U, 1.8S, 6.0E	John Jackson	370	Drl	403	8	12	Little Falls dolomite	..	None	..	Dom	Well not ~~in use.~~ Hydrogen sulfide gas reported.
Mt 27	9U, 2.9S, 6.3E	J. Nellis	420	Drl	115	6	25	Canajoharie and Utica shales	..	Suction	..	Dom	Hydrogen sulfide gas reported.
Mt 29	9U, 2.4S, 7.5E	Raymond Hudson	400	Dug	17	..	..	Recent sand	9	Force	..	Dom	
Mt 31	9U, 3.1S, 8.0E	Earl Dockstader	680	Dug	24	..	..	Pleistocene till	..	Force	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 32	9U, 3.6S, 7.3E	M. Peelor	540	Drl	130	6	18	Glens Falls limestone	60	Force	..	Farm	
Mt 33	9U, 3.8S, 7.3E	Frank Rodnik	520	Drl	120	6	..	Glens Falls limestone	25	Force	..	Farm	
Mt 34	9U, 3.9S, 7.5E	Joseph Winkler	500	Drl	100	6	..	Glens Falls limestone	..	None	..	Farm	Hydrogen sulfide gas reported.
Mt 35	9U, 3.8S, 7.7E	J. S. McLaughlin	600	Dug	..	..	..	Pleistocene till	..	Force	..	Dom	
Mt 36	9U, 4.6S, 6.8E	Village of Nelliston	360	Drl	229	6	5	Little Falls dolomite	10	None	60	PWS	Well not in use.
Mt 37	9U, 5.2S, 7.7E	Groff Brothers	400	Drl	357	8	32	Little Falls dolomite	207	Force	3.5	Farm	Hydrogen sulfide gas reported.
Mt 38	9U, 5.4S, 7.7E	W. H. C. McElroy	340	Drl	48	6	8	Little Falls dolomite	16	Jet	20	PWS	
Mt 39	9U, 4.7S, 8.3E	Paul Souls	660	Dug	15	..	..	Pleistocene till	7	Force	..	Farm	
Mt 40	9U, 3.7S, 9.1E	Herman Fredericks	820	Drl	122	6	5	Canajoharie and Utica shales	52	Force	8	Farm	Hydrogen sulfide gas reported.
Mt 41	9U, 3.5S, 9.0E	A. L. Lanning	800	Drl	152	..	..	Canajoharie and Utica shales	100	Force	..	Farm	
Mt 43	9U, 1.3S, 9.8E	Lloyd Salzman	825	Dug	14	..	..	Pleistocene till	6	Force	..	Dom	
Mt 44	9U, 2.1S, 10.9E	Howard Grey	800	Drl	103	6	20	Canajoharie and Utica shales	20	Force	6.5	Farm	
Mt 45	9U, 2.9S, 11.3E	Harry Dunckel	900	Drl	147	6	8	Little Falls dolomite	50	Force	6.5	Farm	
Mt 46	9U, 4.3S, 10.2E	L. J. Voight	875	Drl	112	6	10	Canajoharie and Utica shales	52	Jet	..	Farm	
Mt 47	9U, 4.6S, 11.0E	Village of Palatine Bridge	810	Drl	625	10	..	Little Falls dolomite (and Potsdam sandstone?)	27	Force	100	PWS	(g)
Mt 48	9U, 5.2S, 10.6E	James Dodson	760	Drl	113	6	38	Canajoharie and Utica shales	38	Force	6	Dom	Well flows intermittently.
Mt 49	9U, 5.3S, 10.7E	Carl Holtz	780	Drl	96	6	18	Canajoharie and Utica shales	..	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 50	9U, 4.6S, 10.1E	Benjamin Nellis	800	Drl	100	6	7	Little Falls dolomite	18	Jet	..	Dom	
Mt 51	9U, 4.6S, 11.1E	Polly Galinski	800	Drl	40	6	6	Little Falls dolomite	0	Jet	5.5	Dom	
Mt 52	9U, 4.5S, 11.4E	Christman Failing	800	Drl	83	8	21	Little Falls dolomite	15	Suction	8.5	Dom	
Mt 53	9U, 6.3S, 10.6E	Deline Van Patten	500	Drl	185	6	6	Little Falls dolomite	121	Force	..	Dom	
Mt 54	9U, 6.5S, 10.5E	Fred Moldt	320	Dug	18	48	..	Pleistocene till	14	Force	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 56	9V, 5.5S, 0.5E	John Enters	820	Drl	100	6	..	Little Falls dolomite	..	Force	..	Dom	
Mt 57	9V, 5.3S, 0.8E	M. E. Joyce	880	Drl	68	6	20	Little Falls dolomite	..	Force	..	Farm	
Mt 58	9V, 4.2S, 0.8E	S. Kandera	880	Drl	85	6	10	Little Falls dolomite	..	None	..	Dom	Well not in use.
Mt 60	9V, 4.5S, 1.0E	Aton Joyce	880	Drl	45	6	..	Little Falls dolomite	..	Force	..	Farm	This well affected by pumping from Mt 47.
Mt 61	9V, 6.3S, 1.6E	George McCaslin	315	Dug	12	..	..	Pleistocene gravel	..	Suction	..	PWS	
Mt 62	9V, 5.7S, 2.3E	R. L. Welles	295	Drl	150	6	..	Little Falls dolomite	..	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 63	9V, 4.5S, 2.8E	F. Fudger	360	Dug	30	..	..	Pleistocene gravel	..	Force	..	Dom	
Mt 64	9V, 4.7S, 2.5E	J. E. Hinkle	700	Dug	20	..	..	Pleistocene till	10	Force	..	Farm	
Mt 65	9V, 2.4S, 1.4E	School District No. 9	840	Drl	69	6	16	Potsdam sandstone	20	Force	..	Dom	([g])
Mt 68	9V, 2.7S, 3.3E	A. H. Dillenbach	560	Drl	170	8	96	Canajoharie and Utica shales	..	Jet	..	Farm	Flowing well. Hydrogen sulfide gas reported. Temperature 42°F.[h]
Mt 69	9V, 2.8S, 4.2E	Earl Wemple	460	Drl	285	6	100	Canajoharie and Utica shales	47	None	..	Dom	Well not in use.
Mt 70	9V, 3.3S, 4.0E	Sandy Flats Farms	450	Drl	135	8	105	Canajoharie and Utica shales	..	None	0	Ind	Well abandoned.
Mt 71	9V, 3.4S, 4.3E	W. Wilson	440	Dug	15	24	..	Pleistocene gravel	12	Force	3	Dom	
Mt 73	9V, 3.8S, 4.9E	William McDuffie	300	Dug	12	..	..	Pleistocene gravel	6	Suction	..	Dom	
Mt 74	9V, 3.3S, 5.0E	George Oare	400	Drl	23	1¼	..	Pleistocene gravel	11	Suction	..	Dom	
Mt 75	9V, 3.1S, 5.2E	Adam Wemple	380	Dug	23	10	..	Pleistocene gravel	20	Suction	..	Dom	Temperature 52°F.[h]
Mt 76	9V, 1.8S, 5.6E	G. M. Woodman	600	Drl	125	6	..	Canajoharie and Utica shales	..	Force	..	Dom	
Mt 77	9V, 3.8S, 6.5E	Harry Burke	400	Drl	101	6	..	Pleistocene till	24	Jet	8	Dom	
Mt 78	9V, 3.2S, 7.1E	Ralph Pepe	300	Drl	42	8	12	Glens Falls and Amsterdam limestones	..	Suction	7.5	Dom	Hydrogen sulfide gas reported.[g]
Mt 79	9V, 3.0S, 7.2E	H. Buckman	400	Drl	113	6	34	Glens Falls and Amsterdam limestones	18	Jet	20	Dom	Hydrogen sulfide gas reported.
Mt 80	9V, 2.2S, 6.9E	Raymond Sioneka	655	Drl	198	6	43	Canajoharie and Utica shales	..	Force	2.5	Farm	Flowing well. Hydrogen sulfide gas reported.
Mt 81	9V, 2.4S, 7.2E	School District No. 12	640	Drl	130	8	5	Glens Falls limestone	8	Force	2.5	Dom	Hydrogen sulfide gas reported.[h]
Mt 82	9V, 2.7S, 7.7E	Clarence Hayes	600	Drl	191	6	62	Canajoharie and Utica shales	30	Force	..	Farm	Hydrogen sulfide gas reported.[h]

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 83	9V, 1.2S, 7.7E	Alden Ecker	600	Drl	186	6	120	Canajoharie and Utica shales	27	Jet	6	Farm	Hydrogen sulfide gas reported.[h]
Mt 84	9V, 1.8S, 8.9E	Raymond Quick	680	Drl	189	..	..	Canajoharie and Utica shales	..	Force	10	Dom	Hydrogen sulfide gas reported.[h]
Mt 85	9V, 1.7S, 9.4E	Richard Hanson	710	Dug	38	..	..	Pleistocene till	..	..	..	Dom	
Mt 86	9V, 1.6S, 9.5E	Victor Duffek	680	Dug	25	..	..	Pleistocene till	20	Force	..	Dom	
Mt 87	9V, 2.2S, 9.9E	Lloyd Saltsman	620	Drl	105	..	6	Canajoharie and Utica shales	..	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 88	9V, 3.0S, 9.9E	A. Weigel	520	Dug	17	..	..	Pleistocene till	10	..	..	Dom	
Mt 89	9V, 3.5S, 9.5E	A. Filbeck	420	Dug	23	..	..	Pleistocene gravel	..	Force	..	Dom	
Mt 90	9V, 4.1S, 9.3E	Damascara Farms	360	Drl	47	6	..	Pleistocene gravel	30	Jet	7	Farm	
Mt 91	9V, 4.3S, 9.7E	P. Menge	320	Drl	150	6	..	Tribes Hill limestone	..	..	..	Dom	Hydrogen sulfide gas reported.
Mt 92	9V, 2.9S, 10.8E	R. W. Gunther	480	Drl	73	6	34	Little Falls dolomite	8	Jet	25	Dom	
Mt 93	9V, 3.2S, 10.7E	F. A. Hoag	460	Drl	18	1¼	..	Pleistocene gravel	16	Suction	..	Dom	([g])
Mt 94	9V, 3.3S, 10.8E	Tribes Hill village cemetery	460	Drl	125	6	..	Little Falls dolomite	..	Force	..	PWS	
Mt 95	9V, 3.1S, 1.1E	William Holdorf	400	Drl	90	4	..	Pleistocene gravel	..	Jet	..	Dom	
Mt 96	9V, 3.0S, 1.1E	Catherine Lyons	445	Dug	40	36	..	Pleistocene gravel	25	Force	..	Dom	
Mt 97	9V, 3.1S, 11.2E	Ira Putnam	360	Dug	18	24	..	Pleistocene gravel	10	Suction	..	Dom	
Mt 98	9V, 1.4S, 11.6E	L. Kubran	680	Drl	40	6	6	Tribes Hill limestone	17	Suction	..	Dom	
Mt 99	9V, 1.5S, 12.1E	A. Vianosky	560	Drl	305	6	6	Little Falls dolomite	5	None	1	Dom	
Mt 100	9W, 2.8S, 0.6E	J. Quinn	380	Drl	104	6	..	Little Falls dolomite	..	Suction	..	Dom	Flowing well.
Mt 101	9W, 2.9S, 1.1E	School District No. 12	360	Dug	6	96	..	Pleistocene gravel	3	Suction	8	Dom	
Mt 102	9W, 3.0S, 0.8E	H. A. Heri	300	Drl	103	6	..	Little Falls dolomite	25	Suction	40	Dom	
Mt 103	9W, 2.9S, 1.0E	Harold Bridge	300	Dug	10	24	..	Pleistocene gravel	7	Force	..	Dom	
Mt 104	9W, 3.0S, 1.2E	Leon Neon Corporation	300	Drl	135	6	..	Little Falls dolomite	..	Force	30	Dom	
Mt 105	9W, 1.8S, 1.2E	Joseph Rogozinski	580	Drl	76	..	40	Canajoharie and Utica shales	..	Force	..	Farm	
Mt 106	9W, 1.8S, 1.3E	Joseph Niegoski	580	Drl	96	..	..	Canajoharie and Utica shales	20	Suction	..	Dom	
Mt 107	9W, 2.4S, 1.7E	H. D. Mabie	500	Dug	30	..	..	Pleistocene till	10	Force	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 108	9W, 2.2S, 2.0E	Donald Isburgh	600	Drl	209	..	50	Canajoharie and Utica shales	..	None	15	Dom	New well; pump not yet installed.
Mt 109	9W, 1.3S, 3.1E	S. M. Saiti	840	Drl	125	8	75	Little Falls dolomite	15	..	3.5	Dom	
Mt 110	9W, 2.0S, 3.5E	Adam Draus	700	Drl	29	6	16	Glens Falls limestone	7	..	..	Dom	
Mt 111	9W, 1.9S, 4.0E	Petersens Garage	740	Drl	65	6	16	Tribes Hill limestone	4	Force	..	Dom	
Mt 112	9W, 2.1S, 4.1E	Heck and Campbell	720	Drl	48	6	20	Tribes Hill limestone	4	None	16	Dom	Well not in use.
Mt 113	9W, 1.6S, 4.8E	William Sworak	740	Drl	60	6	..	Tribes Hill limestone	..	Force	..	Dom	
Mt 114	9W, 4.3S, 3.5E	E. J. Bockman	440	Drl	214	10	15	Little Falls dolomite	..	Force	15	Ind	
Mt 115	9W, 4.4S, 3.7E	M. J. Wytzwal Coal Company	430	Drl	153	6	..	Little Falls dolomite	56	None	5	Ind	Disposal well.
Mt 116	9W, 4.5S, 3.6E	Iroquois Oil Corp.	400	Drl	217	8	42	Little Falls dolomite	60	None	40	Ind	Temperature 50°F. New well; pump not yet installed.[g]
Mt 117	9W, 4.7S, 3.3E	Schine Circuit, Inc.	420	Drl	202	6	7	Little Falls dolomite	30	Force	15	Ind	Temperature 50°F.
Mt 118	9W, 5.0S, 4.0E	F. Lefferts	380	Drl	85	6	..	Little Falls dolomite	..	..	..	Dom	Flowing well.
Mt 119	9W, 5.1S, 4.2E	A. Graff	400	Dug	4	29	..	Pleistocene gravel	..	Suction	..	Farm	Flowing well.
Mt 120	9W, 6.8S, 5.1E	John Hutchinson	600	Drl	92	6	5	Canajoharie and Utica shales	22	Jet	7	Farm	Hydrogen sulfide gas reported.
Mt 121	9W, 5.3S, 4.4E	B. A. DiCaprie	280	Drl	112	6	..	Little Falls dolomite	..	None	..	Dom	Flowing well.
Mt 122	9W, 5.3S, 4.7E	A. Rainone	410	Drl	110	6	..	Little Falls dolomite	10	Force	..	Dom	
Mt 123	9W, 5.4S, 4.6E	E. Dunlap	400	Drl	100	6	..	Little Falls dolomite	..	Suction	..	Dom	
Mt 124	9W, 5.4S, 4.9E	Abbie Davis	350	Drl	82	6	..	Little Falls dolomite	20	Force	..	Dom	([g])
Mt 125	9W, 5.4S, 5.1E	A. Brach	350	Dug	30	..	..	Pleistocene gravel	..	Suction	..	Dom	Hydrogen sulfide gas reported.
Mt 126	9W, 5.4S, 5.2E	W. Templeton	350	Drl	159	6	..	Little Falls dolomite	8	Force	..	Dom	
Mt 127	9W, 5.5S, 5.4E	S. Turnbull	350	Drl	150	6	..	Little Falls dolomite	12	Force	30	Dom	
Mt 128	9W, 5.6S, 5.7E	William De Forest	300	Drl	160	6	50	Little Falls dolomite	+6	None	6	Dom	Hydrogen sulfide gas reported. Flowing well.
Mt 129	9W, 5.7S, 6.0E	H. R. Monat	400	Dug	40	36	..	Pleistocene gravel	10	Suction	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 130	9W, 3.7S, 5.4E	M. Mytyck	690	Drl	80	6	8	Tribes Hill limestone	30	Force	..	Dom	
Mt 131	9W, 3.6S, 5.3E	School District No. 6	690	Drl	48	6	4	Glens Falls limestone	..	Force	..	Dom	
Mt 132	9W, 2.7S, 5.2E	George Quinlan	730	Drl	48	6	4	Little Falls dolomite	..	..	4	Farm	
Mt 133	9W, 3.6S, 6.6E	Rheinold Balfony	700	Drl	60	..	10	Little Falls dolomite	20	Suction	..	Farm	
Mt 134	9W, 3.1S, 6.7E	N. P. Grade	746	Drl	65	..	10	Little Falls dolomite	20	Suction	..	Farm	
Mt 135	9W, 2.2S, 7.5E	Charles Engel	747	Drl	74	..	5	Little Falls dolomite	10	Force	30	Dom	([g])
Mt 136	9W, 2.2S, 7.5E	Anthony Pawlowski	750	Drl	57	..	6	Little Falls dolomite	20	Jet	..	Dom	
Mt 137	9W, 2.2S, 7.9E	W. Andrzezewski	700	Drl	112	..	6	Little Falls dolomite	42	Force	..	Farm	
Mt 138	9W, 6.1S, 6.9E	Roy Overbaugh	400	Drl	107	6	..	Little Falls dolomite	..	Suction	33	Dom	Flowing Well.
Mt 139	9W, 6.1S, 7.0E	Kenneth Johnson	300	Drl	..	8	..	Little Falls dolomite	..	None	..	Dom	Hydrogen sulfide gas reported. Flowing well.
Mt 141	9W, 6.9S, 11.5E	A. Malpas	400	Dug	8	24	..	Pleistocene till	..	Suction	..	Dom	
Mt 142	9U, 0.8S, 0.4E	E. I. Shoeverman	640	Dug	18	..	..	Pleistocene till	..	Suction	..	Dom	
Mt 143	9U, 1.0S, 1.0E	George Dnab	640	Dug	21	120	..	Pleistocene till	5	Suction	..	Farm	
Mt 144	9U, 0.5S, 1.3E	Charles Campion	320	Drl	58	6	..	Pleistocene gravel	..	..	52	Dom	Hydrogen sulfide gas reported.
Mt 145	9U, 0.4S, 1.6E	W. E. Brown	320	Drl	36	1¼	..	Pleistocene gravel	20	Force	..	Dom	
Mt 146	9U, 0.5S, 1.6E	Charles Campion	320	Drl	80	8	..	Canajoharie and Utica shales	60	Force	..	Farm	Hydrogen sulfide gas reported; temperature 50°F.
Mt 147	9U, 0.5S, 1.7E	William Carson	320	Drl	100	6	20	Canajoharie and Utica shales	..	Jet	8	Dom	Temperature 45°F.
Mt 148	9U, 6.0S, 3.6E	Ogden Walrath	340	Drl	40	6	..	Little Falls dolomite	..	Force	..	Dom	
Mt 151	9U, 0.9S, 4.1E	R. Schevenman	780	Drl	348	6	18	Canajoharie and Utica shales	6	Force	..	Farm	Temperature 50°F.
Mt 152	9U, 2.0S, 0.5E	Eugene Loren	680	Drl	..	6	..	Canajoharie and Utica shales	..	Force	..	Farm	
Mt 153	9U, 8.1S, 0.8E	Howard Ester	740	Drl	125	6	..	Canajoharie and Utica shales	..	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 155	9U, 3.0S, 2.2E	Edward Youngs	600	Dug	..	..	..	Pleistocene till	..	Force	..	Dom	
Mt 156	9U, 3.3S, 3.0E	Glen Douglas	600	Drl	212	8	40	Canajoharie and Utica shales	50	Force	4	Dom	Hydrogen sulfide gas reported.

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 157	9U, 2.5S, 3.4E	B. Haensel	700	Dug	20	..	..	Pleistocene till	6	Force	..	Dom	
Mt 158	9U, 2.6S, 3.6E	A. Nellis	700	Dug	20	..	..	Pleistocene till	6	Suction	..	Dom	
Mt 159	9U, 3.1S, 4.2E	William Swartz	660	Drl	159	6	2	Canajoharie and Utica shales	12	Force	..	Farm	
Mt 160	9U, 3.9S, 4.4E	School District No. 4	680	Drl	..	6	..	Canajoharie and Utica shales	..	Force	..	PWS	
Mt 161	9U, 4.1S, 2.8E	Caleb Watkins	520	Drl	60	6	57	Canajoharie and Utica shales	15	Pitcher	..	Dom	([g])
Mt 162	9U, 4.0S, 1.8E	Harry Wetterau	660	Drl	95	6	..	Canajoharie and Utica shales	8	Force	..	Dom	Hydrogen sulfide gas reported.
Mt 163	9U, 4.5S, 1.1E	J. C. Smith	600	Dug	20	..	..	Pleistocene till	12	Force	..	Dom	
Mt 164	9U, 4.4S, 2.4E	Otsquago Mill	510	Drl	330	6	..	Canajoharie and Utica shales	..	..	..	Irr	Hydrogen sulfide gas reported.
Mt 166	9U, 4.8S, 2.0E	Floyd Smith	600	Dug	6	48	..	Pleistocene till	2	Suction	..	Farm	
Mt 167	9U, 5.8S, 1.1E	C. Crews	640	Dug	..	..	..	Pleistocene till	..	Suction	..	Dom	
Mt 168	9U, 5.9S, 2.0E	E. Brownell	680	Drl	126	6	..	Pleistocene till	56	..	..	Farm	
Mt 169	9U, 6.8S, 1.8E	T. A. Wharmsby	760	Dug	16	..	..	Pleistocene till	..	Force	..	Dom	
Mt 170	9U, 8.7S, 0.8E	Edward Moreray	920	Drl	100	6	..	Canajoharie and Utica shales	..	Force	..	Farm	
Mt 171	9U, 9.4S, 0.4E	Alton Dingman	1,070	Drl	354	6	40	Canajoharie and Utica shales	40	None	3	None	Temperature 48°F. Contains brine.
Mt 172	9U, 9.2S, 1.7E	George Van Vranken	980	Drl	229	6	97	Canajoharie and Utica shales	16	Force	3.5	Farm	
Mt 173	9U, 8.0S, 2.3E	Clifford Moyer	980	Drl	96	6	7	Canajoharie and Utica shales	22	Jet	6	Farm	Hydrogen sulfide gas reported.
Mt 174	9U, 8.9S, 2.8E	J. F. McLaughlin	..	Drl	90	6	15	Canajoharie and Utica shales	10	Jet	7.5	Farm	
Mt 175	9U, 8.6S, 3.3E	Clarence Rockwell	900	Drl	110	6	40	Canajoharie and Utica shales	18	Jet	9	Farm	
Mt 176	9U, 8.0S, 3.1E	Abram Gardner	940	Drl	190	6	4	Canajoharie and Utica shales	40	Force	..	Farm	Hydrogen sulfide gas reported.
Mt 177	9U, 7.1S, 3.0E	Leo Knoeck	750	Dug	25	..	..	Pleistocene till	..	Suction	..	Farm	
Mt 178	9U, 7.0S, 4.3E	Stanley Bowers	700	Dug	25	..	..	Pleistocene till	..	Force	..	Dom	
Mt 179	9U, 6.3S, 4.3E	Abram Slingerland	700	Dug	..	..	..	Pleistocene till	..	Force	..	Dom	
Mt 180	9U, 5.7S, 3.5E	T. Youngs	600	Dug	20	..	..	Pleistocene till	..	Force	..	Dom	
Mt 181	9U, 5.6S, 5.4E	Charles Chandler	600	Drl	100	6	50	Canajoharie and Utica shales	..	Force	20	Dom	Flows intermittently.
Mt 182	9U, 4.9S, 4.8E	M. Geissler	400	Dug	20	..	..	Pleistocene gravel	..	..	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 183	9U, 3.6S, 6.0E	L. P. Hudson	300	Drl	45	6	..	Pleistocene gravel	20	Suction	8	Dom	Temperature 47°F.
Mt 184	9U, 3.9S, 6.0E	Sandy Hill School	380	Drl	75	..	40	Glens Falls limestone	..	..	..	Dom	
Mt 185	9U, 4.5S, 6.3E	S. Adler, Inc.	315	Drl	37	8	37	Pleistocene gravel	7	..	..	Ind	Temperature 48°F.[g]
Mt 186	9U, 5.4S, 6.7E	Robert Shelp	400	Drl	95	6	55	Little Falls dolomite	21	Force	3	Dom	
Mt 187	9U, 6.0S, 7.2E	William Lettis	400	Dug	25	..	..	Pleistocene gravel	12	Suction	..	Dom	
Mt 188	9U, 6.9S, 6.7E	William Fisk	700	Drl	260	6	..	Canajoharie and Utica shales	75	Force	3	Farm	
Mt 189	9U, 7.4S, 6.0E	Leslie Waner	780	Drl	40	5	..	Pleistocene till	..	Suction	..	Ind	
Mt 190	9U, 7.7S, 5.7E	Herbert Heiser	780	Drl	132	6	10	Canajoharie and Utica shales	40	Force	..	Farm	
Mt 191	9U, 7.8S, 5.9E	Frank Jewell	780	Drl	386	8	..	Canajoharie and Utica shales	..	Force	..	Farm	Hydrogen sulfide gas reported.
Mt 192	9U, 8.2S, 5.2E	Charles McCaskey	780	Drl	31	5	12	Canajoharie and Utica shales	12	Force	..	Farm	
Mt 193	9U, 8.7S, 4.9E	Richard Hill	880	Dug	10	..	..	Pleistocene till	5	Force	..	Dom	
Mt 194	9U, 10.3S, 3.4E	C. N. Robinson	720	Drl	134	6	..	Canajoharie and Utica shales	..	Force	..	Farm	Flowing well.
Mt 195	9U, 10.8S, 3.2E	C. J. Price	735	Dug	12	..	..	Pleistocene till	..	Force	..	Dom	
Mt 196	9U, 10.8S, 3.3E	Charles Endsly	735	Dug	9	..	..	Pleistocene till	8	Suction	..	Dom	
Mt 197	9U, 10.4S, 4.5E	L. Countryman	725	Drl	105	6	..	Canajoharie and Utica shales	..	None	6	Dom	Flowing well. New well; pump not yet installed.[h]
Mt 198	9U, 10.0S, 4.7E	V. J. Hawkins	860	Drl	370	6	103	Canajoharie and Utica shales	97	Force	1.5	Dom	Water contains brine.
Mt 199	9U, 10.5S, 5.2E	S. L. Smith	725	Drl	133	6	..	Canajoharie and Utica shales	..	Force	..	Dom	Hydrogen sulfide gas reported; flowing well.
Mt 201	9U, 9.2S, 6.4E	Canajoharie Country Club	720	Drl	589	6	17	Canajoharie and Utica shales	9	..	4	Com	
Mt 202	9U, 8.6S, 7.2E	W. W. Garlock	740	Dug	25	..	..	Pleistocene till	..	Force	..	Dom	
Mt 203	9U, 8.4S, 7.3E	C. M. Scott	650	Drl	99	8	99	Pleistocene till	..	Force	..	Dom	([g])
Mt 204	9U, 8.3S, 7.4E	W. C. Shults	650	Drl	40	6	..	Pleistocene till	30	Jet	..	Farm	
Mt 205	9U, 7.5S, 7.7E	J. V. Fredericks	675	Drl	100	6	..	Canajoharie and Utica shales	..	..	..	Dom	Hydrogen sulfide gas reported.
Mt 206	9U, 7.4S, 8.2E	Carl Bosch	520	Drl	51	6	45	Canajoharie and Utica shales	..	Jet	..	Dom	
Mt 207	9U, 7.4S, 8.4E	Peter Kochen	500	Drl	146	6	146	Pleistocene till	80	Force	..	Dom	
Mt 208	9U, 6.5S, 8.8E	Dairymens Cooperative	300	Drl	60	8	..	Pleistocene gravel	..	..	..	Ind	Hydrogen sulfide gas reported.

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 209	9U, 6.5S, 8.8E	Beech-Nut Packing Co.	300	Drl	625	..	..	Little Falls dolomite	20	Force	200	Ind	Temperature 49°F. Hydrogen sulfide gas reported.
Mt 210	9U, 6.5S, 8.9E	Beech-Nut Packing Co.	300	Drl	80	..	..	Pleistocene gravel	..	..	40	Ind	(g)
Mt 211	9U, 6.5S, 9.0E	Beech-Nut Packing Co.	300	Drl	259	10	..	Little Falls dolomite	20	Force	200	Ind	8emperature 49°F. Hydrogen sulfide gas reported.
Mt 212	9U, 6.4S, 9.1E	Beech-Nut Packing Co.	300	Drl	212	8	..	Little Falls dolomite	..	..	..	Ind	
Mt 214	9U, 9.1S, 9.3E	William Hoyt	700	Drl	336	8	..	Canajoharie and Utica shales	150	Force	5	Farm	
Mt 215	9U, 9.2S, 10.0E	E. R. Pickett	720	Drl	88	8	..	Pleistocene gravel	43	Force	12	Farm	
Mt 216	9U, 10.3S, 8.8E	H. C. Groat	700	Drl	289	6	289	Canajoharie and Utica shales	199	Force	36	Farm	
Mt 217	9U, 11.3S, 7.7E	Anna Day	717	Dug	16	..	..	Pleistocene till	10	Suction	..	Dom	Hydrogen sulfide gas reported.
Mt 218	9U, 11.1S, 7.3E	Harry Barnes	718	Drl	10	1¼	..	Pleistocene till	5	Suction	..	Dom	
Mt 219	9U, 11.2S, 6.9E	Raymond McCullough	700	Drl	108	6	..	Pleistocene till	20	Suction	..	Farm	
Mt 220	9U, 1.0S, 1.0E	George Budd	960	Drl	267	6	10	Canajoharie and Utica shales	115	Force	8	Farm	
Mt 221	9U, 12.1S, 8.6E	M. Hodge	840	Drl	165	..	..	Pleistocene till	..	Force	..	Dom	
Mt 222	9U, 13.0S, 9.9E	John Johnson	1,340	Drl	125	20	..	Schenectady formation	..	..	..	Farm	
Mt 223	9U, 12.0S, 9.6E	L. E. Button	1,165	Dug	18	..	..	Pleistocene till	9	Suction	..	Dom	
Mt 224	9U, 11.4S, 10.2E	Frank McLacklan	1,000	Drl	90	..	55	Canajoharie and Utica shales	6	..	2	Dom	
Mt 225	9U, 7.8S, 12.2E	Spencer Greco	500	Drl	100	6	7	Little Falls dolomite	18	Jet	7.5	Dom	
Mt 226	9V, 9.4S, 1.1E	Dewey Dierendorf	820	Drl	38	6	..	Glens Falls and Amsterdam limestones	20	Suction	..	Farm	
Mt 227	9V, 9.5S, 3.7E	James Pulver	900	Drl	210	6	40	Canajoharie and Utica shales	8	..	20	Farm	Temperature 49°F; hydrogen sulfide gas reported.
Mt 228	9V, 9.9S, 2.1E	Birdsley Darrow	990	Drl	125	6	15	Canajoharie and Utica shales	..	..	5	Farm	
Mt 229	9V, 10.7S, 3.0E	Harry Bryant	940	Drl	185	6	50	Canajoharie and Utica shales	0	Jet	..	Dom	(g)
Mt 230	9V, 10.9S, 1.3E	George Darrow	960	Drl	85	6	..	Schenectady formation	15	Jet	..	Farm	
Mt 231	9U, 10.9S, 12.5E	B. H. Meyers	740	Drl	125	..	85	Canajoharie and Utica shales	22	Jet	..	Farm	
Mt 233	9V, 12.7S, 3.9E	Robert Mingay	1,060	Dug	12	..	..	Pleistocene till	8	..	..	Dom	Hydrogen sulfide gas reported.

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 234	9U, 12.7S, 11.0E	Frank Mikapa	1,200	Drl	96	..	11	Schenectady formation	48	Jet	9	Farm	([g])
Mt 235	9U, 13.2S, 12.1E	Herbert Kane	1,000	Dug	11	..	..	Pleistocene till	3	Force	..	Dom	
Mt 236	9U, 13.3S, 12.4E	Herbert Kane	1,000	Dug	18	..	..	Pleistocene till	12	Force	..	Dom	
Mt 237	9V, 14.6S, 0.4E	Levi Hendricks	1,060	Drl	38	6	..	Schenectady formation	20	Suction	..	Farm	
Mt 238	9V, 13.2S, 0.6E	George Quackenbush	960	Drl	46	6	..	Schenectady formation	15	Suction	..	Farm	Hydrogen sulfide gas reported.
Mt 239	9V, 13.1S, 0.9E	E. G. Bartlet	1,000	Drl	90	6	..	Schenectady formation	20	Suction	..	Dom	
Mt 240	9V, 13.1S, 1.2E	Arthur Lyker	1,048	Drl	150	6	10	Canajoharie and Utica shales	..	None	..	Dom	Well not used.
Mt 241	9V, 13.3S, 1.3E	Datum Putnam	1,000	Dug	20	..	..	Pleistocene till	10	Force	..	Dom	
Mt 242	9V, 13.8S, 1.5E	William Vankersen	1,040	Drl	120	6	78	Schenectady formation	..	Force	..	Dom	
Mt 243	9V, 14.4S, 1.7E	Beatrice Kilmartin	1,080	Drl	100	6	65	Schenectady formation	2	Suction	..	Farm	
Mt 244	9V, 15.1S, 2.2E	Vesta Stevens	1,100	Dug	20	..	..	Pleistocene till	..	Force	..	Dom	
Mt 245	9V, 15.5S, 2.5E	Robert Ryder	1,160	Dug	20	..	..	Pleistocene till	..	Force	..	Dom	
Mt 246	9V, 6.3S, 2.6E	Volbert Vrooman	300	Drl	112	6	..	Pleistocene gravel	20	Force	..	Dom	Hydrogen sulfide and natural gas reported.
Mt 247	9V, 6.1S, 3.0E	Charles Winsman	300	Dug	15	..	..	Pleistocene gravel	14	Force	..	Dom	
Mt 250	9V, 5.6S, 3.3E	M. Ross	280	Drl	109	6	60	Canajoharie and Utica shales	30	Force	..	Dom	
Mt 251	9V, 5.5S, 3.7E	Veeder and Ouderkirk	300	Drl	315	8	112	Little Falls dolomite	26	Force	40	Dom	Temperature 55°F. Hydrogen sulfide gas reported.[g]
Mt 252	9V, 5.6S, 3.7E	Clarence Coddington	300	Drl	118	6	118	Pleistocene gravel	20	Jet	..	Dom	
Mt 253	9V, 8.0S, 4.3E	William Bayes	650	Drl	122	6	30	Canajoharie and Utica shales	20	..	..	Farm	Hydrogen sulfide gas reported.
Mt 254	9V, 8.2S, 4.4E	John Burley	620	Drl	96	6	9	Canajoharie and Utica shales	14	Jet	20	Dom	([g])
Mt 255	9V, 8.7S, 4.7E	John Leonard	780	Drl	98	6	6	Canajoharie and Utica shales	30	Jet	..	Farm	Hydrogen sulfide gas reported.[g]
Mt 256	9V, 9.1S, 4.5E	Joseph Mazur	880	Drl	77	6	..	Canajoharie and Utica shales	5	Force	2.5	Dom	
Mt 257	9V, 7.0S, 5.9E	B. Yerkeweez	580	Drl	282	6	14	Canajoharie and Utica shales	42	Force	2.8	Farm	Hydrogen sulfide gas reported.[g]
Mt 258	9V, 7.1S, 6.3E	Harold Webb	560	Drl	275	6	..	Canajoharie and Utica shales	9	None	..	Dom	Well not in use.

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 259	9V, 6.6S, 6.6E	Arnold Schlotte	580	Drl	315	6	..	Canajoharie and Utica shales	5	None	..	Dom	Well not in use.
Mt 260	9V, 6.1S, 7.3E	Ingersoll Brothers	500	Drl	310	6	..	Canajoharie and Utica shales	20	Force	11	Farm	
Mt 261	9V, 6.0S, 7.5E	R. Kubly	480	Dug	30	..	..	Pleistocene till	..	Suction	..	Farm	
Mt 262	9V, 5.1S, 6.9E	E. B. Vickerson	500	Dug	35	..	..	Pleistocene till	..	..	..	Dom	
Mt 263	9V, 4.9S, 7.0E	Robert Gifford	500	Dug	40	..	..	Pleistocene till	..	Force	..	Dom	
Mt 264	9V, 4.1S, 6.5E	Fultonville Water Supply	420	Drl	360	..	..	Little Falls dolomite	..	Force	..	PWS	([g])
Mt 265	9V, 3.8S, 6.5E	Fultonville Water Supply	310	Drl	280	12 to 8	25	Little Falls dolomite	22	Force	125	PWS	Hydrogen sulfide gas reported.[g]
Mt 266	9V, 3.9S, 6.7E	Glen Mohawk Milk Association	320	Drl	166	8	90	Little Falls dolomite	14	Force	..	Ind	Hydrogen sulfide gas reported.
Mt 267	9V, 3.8S, 7.7E	E. J. Friers	300	Dug	35	48	..	Pleistocene gravel	15	Force	..	Dom	
Mt 268	9V, 3.9S, 7.8E	Peter Vrooman	300	Dug	20	36	..	Pleistocene gravel	10	Force	..	Dom	
Mt 269	9V, 4.9S, 9.4E	Auriesville School	300	Drl	187	6	..	Canajoharie and Utica shales	45	Force	5	Dom	Hydrogen sulfide gas reported.
Mt 270	9V, 5.0S, 9.9E	Auriesville School	320	Drl	153	10	115	Canajoharie and Utica shales	45	Force	30	Dom	Hydrogen sulfide gas reported.[h]
Mt 271	9V, 5.2S, 10.2E	Auriesville School	400	Drl	515	8	187	Little Falls dolomite	175	Force	8	Dom	Hydrogen sulfide gas reported.[h]
Mt 272	9V, 7.3S, 7.8E	A. G. Moore	640	Dug	20	..	..	Pleistocene till	10	Force	..	Farm	Temperature 50°F.
Mt 273	9V, 7.2S, 8.1E	R. L. Steele	680	Dug	25	..	..	Pleistocene till	20	Suction	..	Dom	
Mt 274	9V, 7.0S, 8.6E	H. N. Van Schaaick	660	Dug	35	..	..	Pleistocene till	25	Force	..	Dom	
Mt 275	9V, 7.5S, 10.0E	Edward Lang	580	Drl	110	6	..	Canajoharie and Utica shales	..	Force	..	Farm	Hydrogen sulfide gas reported.
Mt 276	9V, 6.8S, 10.6E	Ripley Brothers	400	Drl	147	6	44	Canajoharie and Utica shales	..	Force	8	Dom	
Mt 279	9V, 7.7S, 11.3E	C. Anmerall	350	Dug	19	..	..	Pleistocene gravel	18	Suction	..	Dom	
Mt 280	9V, 8.3S, 11.2E	Edgar Swart	360	Dug	15	..	..	Pleistocene gravel	12	Force	..	Dom	
Mt 281	9V, 9.4S, 11.2E	Dan Argerswiger	540	Dug	15	..	..	Pleistocene gravel	..	Force	..	Farm	
Mt 282	9V, 9.9S, 7.3E	A. Palin	1,080	Drl	60	6	10	Schenectady formation	9	..	19	Farm	
Mt 283	9V, 10.6S, 8.1E	H. Petkevech	1,160	Drl	100	6	22	Schenectady formation	19	..	0.8	Dom	
Mt 284	9V, 10.7S, 5.9E	J. Devinsky	1,040	Drl	73	6	..	Schenectady formation	..	..	..	Farm	([g])
Mt 285	9V, 13.3S, 1.3E	F. J. Ecker	1,140	Dug	33	..	..	Pleistocene till	20	Suction	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 286	9V, 13.5S, 5.2E	H. Emken	1,100	Drl	100	6	8	Schenectady formation	..	Force	12	Dom	
Mt 287	9V, 13.7S, 5.0E	Neil McDurfee	1,060	Drl	150	6	..	Schenectady formation	..	Jet	30	Dom	
Mt 288	9V, 13.9S, 4.7E	J. J. Goldman	1,000	Dug	14	..	..	Pleistocene till	12	Suction	..	Dom	
Mt 289	9V, 14.0S, 4.8E	B. B. Veeder	1,000	Drl	130	6	..	Schenectady formation	..	Suction	..	Dom	Flowing well.
Mt 290	9V, 15.4S, 4.9E	Dietrich Grell	1,200	Drl	248	6	175	Schenectady formation	104	None	2	Dom	New well; pump not yet installed.
Mt 291	9V, 15.4S, 4.9E	School District No. 3	1,040	Drl	194	6	..	Pleistocene gravel	77	Force	..	Dom	
Mt 292	9V, 14.0S, 8.1E	Anthony Lappas	1,240	Dug	23	36	..	Pleistocene till	7	Suction	..	Dom	
Mt 293	9V, 14.5S, 8.7E	O. R. Schurig	1,380	Dug	22	36	..	Pleistocene till	5	Suction	..	Dom	Temperature 55°F.
Mt 294	9V, 10.7S, 11.7E	Belniak Farm	460	Dug	20	1¼	..	Pleistocene gravel	..	Suction	..	Dom	
Mt 295	9V, 11.2S, 11.8E	Paul Mosher	640	Dug	16	48	..	Pleistocene till	7	Suction	..	Dom	
Mt 296	9V, 11.7S, 11.6E	Alex Gombar	820	Dug	16	..	..	Pleistocene till	10	Suction	..	Dom	
Mt 297	9V, 11.8S, 12.0E	C. A. Berner	600	Dug	14	60	..	Canajoharie and Utica shales	7	Suction	..	Dom	
Mt 298	9V, 12.0S, 11.7E	George Peck	820	Dug	13	..	..	Pleistocene till	6	Suction	..	Dom	
Mt 299	9V, 12.7S, 11.9E	Olin Tullen	700	Dug	12	..	..	Pleistocene till	8	Suction	..	Dom	Temperature 50°F.
Mt 300	9V, 13.2S, 12.2E	E. H. Reid	600	Dug	28	..	..	Pleistocene gravel	13	Suction	..	Dom	
Mt 301	9V, 13.4S, 12.2E	M. Thieband	520	Drl	95	6	..	Canajoharie and Utica shales	..	Suction	..	Dom	Flowing well.[g]
Mt 302	9V, 13.5S, 12.2E	M. Thieband	520	Drl	58	6	10	Canajoharie and Utica shales	10	Suction	3.5	Dom	
Mt 303	9V, 13.5S, 12.2E	M. E. Dobert	540	Drl	114	6	10	Canajoharie and Utica shales	18	Suction	3	Dom	Hydrogen sulfide gas reported. Temperature 55°F.
Mt 304	9V, 13.5S, 12.1E	M. V. Thieband	540	Drl	88	6	13	Canajoharie and Utica shales	..	..	1.5	Dom	
Mt 305	9V, 3.9S, 10.8E	Samuel Sherman	300	Drl	96	6	..	Pleistocene gravel	12	Jet	5.5	Dom	
Mt 306	9V, 3.8S, 10.9E	Premier Broom and Brush Co.	300	Drl	175	6	150	Little Falls dolomite	4	..	..	Ind	
Mt 307	9V, 4.0S, 10.8E	George Albeis	300	Drl	100	6	..	Pleistocene gravel	14	Force	45	Dom	Temperature 52°F.
Mt 308	9V, 3.9S, 10.9E	William Hovey	300	Drl	99	5	..	Pleistocene gravel	12	Jet	5.5	Dom;	([g])
Mt 309	9V, 4.1S, 11.1E	William Bobilin	300	Drl	102	6	..	Pleistocene gravel	17	Force	30	Dom	([h])
Mt 310	9V, 4.0S, 11.4E	Montgomery County Eastern Cooperative Dairy Co.	300	Drl	200	6	..	Little Falls dolomite	35	Suction	..	Ind	Temperature 50°F.

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Continued)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 311	9V, 3.9S, 11.7E	Voorhees Brothers	340	Drl	97	6	7	Little Falls dolomite	..	..	20	Dom	
Mt 312	9W, 4.1S, 0.6E	J. A. Hutchinson	480	Drl	186	6	6	Canajoharie and Utica shales	12	Jet	0.5	Farm	Hydrogen sulfide gas reported.
Mt 313	9W, 4.4S, 1.2E	Charles Hirschfield	459	Drl	202	6	75	Canajoharie and Utica shales	20	..	2.5	Farm	Hydrogen sulfide gas reported.
Mt 314	9W, 4.6S, 1.5E	Warren Meade	450	Drl	217	6	100	Canajoharie and Utica shales	15	..	..	Farm	No yield before blasting.
Mt 315	9V, 5.9S, 12.4E	A. C. Hortsman	620	Drl	96	6	20	Canajoharie and Utica shales	17	Jet	20	Farm	(g)
Mt 316	9V, 6.0S, 12.5E	Charles Francisco	680	Drl	125	6	22	Canajoharie and Utica shales	8	Force	0.3	Farm	
Mt 317	9V, 8.0S, 11.7E	Lang Brothers	400	Drl	100	6	..	Pleistocene gravel	14	Jet	25	Farm	
Mt 318	9W, 7.9S, 0.4E	Walter Weike	700	Drl	95	6	..	Canajoharie and Utica shales	18	Suction	4	Dom	
Mt 319	9V, 10.2S, 11.7E	Lost Valley Camps	440	Drl	100	8	15	Canajoharie and Utica shales	..	Force	..	Dom	Hydrogen sulfide gas reported. Temperature 50°F.[g]
Mt 320	9V, 10.2S, 12.2E	C. McKinney	650	Dug	26	..	..	Pleistocene till	..	..	..	Farm	
Mt 321	9W, 10.0S, 0.2E	D. S. Van Horne	800	Drl	125	8	8	Canajoharie and Utica shales	2	Suction	3.5	Dom	
Mt 322	9V, 10.6S, 11.6E	John Turner	440	Dug	20	48	..	Pleistocene till	16	Suction	..	Dom	
Mt 323	9V, 10.5S, 12.4E	Anthony Svegzda	720	Dug	..	..	..	Pleistocene till	..	Force	..	Farm	Three similar wells at this location.
Mt 324	9V, 11.9S, 12.7E	L. Humphrey	660	Dug	22	..	..	Pleistocene till	..	Force	..	Dom	
Mt 325	9W, 12.1S, 0.2E	Leo Kennedy	680	Dug	..	..	..	Pleistocene till	..	Force	..	Dom	
Mt 326	9W, 12.3S, 0.2E	Frank Majeski	660	Dug	..	..	..	Pleistocene till	..	Force	..	Dom	
Mt 327	9W, 10.8S, 0.9E	T. W. Gleason	940	Drl	83	6	50	Schenectady formation	20	Jet	..	Dom	
Mt 328	9W, 8.1S, 1.7E	A.L. Brown	600	Dug	21	48	..	Pleistocene till	7	Force	..	Dom	
Mt 329	9W, 8.0S, 1.8E	Ernest Shuttleworth	560	Drl	300	8	125	Canajoharie and Utica shales	..	Jet	5	Com	Hydrogen sulfide gas reported. Flowing well.[h]
Mt 330	9W, 7.7S, 1.6E	H. S. Howard	560	Dug	14	24	..	Pleistocene till	..	Suction	..	Dom	
Mt 331	9W, 7.0S, 1.3E	Mary Slezak	623	Dug	13	..	..	Pleistocene till	6	Force	..	Dom	
Mt 332	9W, 6.6S, 1.3E	Smith and Rink	600	Dug	21	..	..	Pleistocene till	4	Force	..	Dom	
Mt 333	9W, 6.4S, 2.3E	John Czelusniah	700	Dug	20	..	..	Pleistocene till	10	Force	..	Dom	
Mt 334	9W, 6.0S, 2.5E	....	710	Dug	..	..	..	Pleistocene till	..	..	..	None	
Mt 335	9W, 5.6S, 2.3E	Nadler Farm No. 3	600	Drl	500	..	..	Canajoharie and Utica shales	6	Force	..	Dom	

See footnotes at end of table.

Table 11.—Records of selected wells in Montgomery County, New York (Concluded)

Well number	Location[a]	Owner	Altitude above sea level (feet)[b]	Type of well[c]	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)[d]	Method of lift	Yield (gallons per minute)	Use[e]	Remarks
Mt 336	9W, 5.9S, 2.3E	Schuyler Voorhees Dairy	520	Drl	120	6	8	Canajoharie and Utica shales	20	Force	..	Farm	Hydrogen sulfide gas reported.
Mt 337	9W, 4.9S, 2.5E	Anthony Salce	405	Drl	220	8	..	Little Falls dolomite	31	Force	3.5	Dom	
Mt 338	9W, 5.2S, 3.3E	Peter Raczkowski	320	Drl	144	6	20	Little Falls dolomite	15	Jet	3.5	Com	
Mt 339	9W, 5.4S, 3.6E	A. McClumpha	380	Dug	28	60	..	Pleistocene till	6	Force	..	Dom	
Mt 340	9W, 5.7S, 3.6E	Edward Rhode	460	Dug	20	..	..	Pleistocene till	8	Suction	..	Dom	
Mt 341	9W, 6.5S, 3.8E	Rudolph Sievers	600	Drl	300	6	6	Canajoharie and Utica shales	6	Force	3	Farm	
Mt 342	9W, 7.2S, 4.3E	C. Brown	640	Dug	12	24	..	Pleistocene till	..	Suction	3.5	Dom	
Mt 343	9W, 7.7S, 3.1E	T. R. Staley	800	Dug	15	..	..	Pleistocene till	7	Force	3	Dom	
Mt 344	9W, 7.6S, 3.8E	Thomas Langley	700	Dug	25	..	..	Pleistocene till	12	Suction	3.5	Dom	
Mt 345	9W, 8.9S, 2.8E	E. G. Vander Veer	760	Drl	260	6	..	Canajoharie and Utica shales	40	Force	..	Farm	
Mt 347	9W, 8.3S, 3.8E	H. E. Snyder	850	Dug	13	..	..	Pleistocene till	10	Force	..	Dom	
Mt 348	9W, 8.4S, 4.2E	Fred Geiger	760	Drl	350	6	..	Canajoharie and Utica shales	40	Force	..	Farm	
Mt 349	9W, 8.3S, 4.6E	Bulls Head School	800	Drl	300	6	..	Canajoharie and Utica shales	..	Force	..	Dom	
Mt 350	9W, 9.6S, 3.3E	Frank Hartman	760	Drl	60	6	7	Canajoharie and Utica shales	28	Suction	30	Farm	
Mt 351	9W, 8.8S, 5.7E	Alfred Cooper	960	Dug	12	..	..	Pleistocene till	10	Suction	..	Dom	
Mt 352	9W, 8.7S, 5.6E	Frank Wheaton	980	Drl	129	7	..	Canajoharie and Utica shales	..	Force	..	Dom	(g)
Mt 353	9W, 8.6S, 5.4E	L. W. Kruegen	925	Dug	14	..	..	Pleistocene till	7	Force	..	Dom	
Mt 354	9W, 7.8S, 5.7E	J. Slezak	960	Dug	25	..	..	Pleistocene till	12	Force	..	Dom	
Mt 355	9W, 7.3S, 5.4E	H. Steele	700	Dug	20	..	..	Pleistocene till	..	Force	..	Farm	
Mt 357	9W, 6.1S, 4.8E	Thomas Burrell	400	Drl	139	6	8	Little Falls dolomite	38	Force	..	Dom	
Mt 358	9W, 5.8S, 4.9E	William Nicholas	300	Drl	59	6	4	Little Falls dolomite	12	Force	..	Dom	(g)
Mt 359	9W, 6.3S, 5.4E	Riley Schmid	460	Drl	125	6	..	Little Falls dolomite	..	..	..	Farm	
Mt 360	9W, 6.9S, 5.7E	George Herrick	540	Dug	20	..	..	Pleistocene till	10	None	..	Farm	Gravity flow to buildings. Hydrogen sulfide gas reported.
Mt 362	9W, 6.2S, 6.2E	Edward Miller	300	Dug	16	48	..	Pleistocene gravel	13	Suction	..	Dom	
Mt 363	9W, 6.3S, 6.4E	A. A. Kline	300	Dug	13	60	..	Pleistocene gravel	7	Pitcher	..	Dom	
Mt 364	9W, 6.6S, 7.1E	C. Van Voaft	300	Dug	18	48	..	Pleistocene till	7	..	..	Dom	

a. For explanation of location symbols see section entitled, "Methods of investigation."
b. Approximate altitude from topographic map.
c. Drl, drilled; Drv, driven.
d. Reported average water level.
e. Com, commercial; Dom, domestic; Ind, industrial; PWS, public water supply.
f. Measurements since January 1946 on file at the office of the U. S. Geological Survey, Ground Water Branch, Albany, New York.
g. For chemical analysis see table 8.
h. For additional data see table 10.